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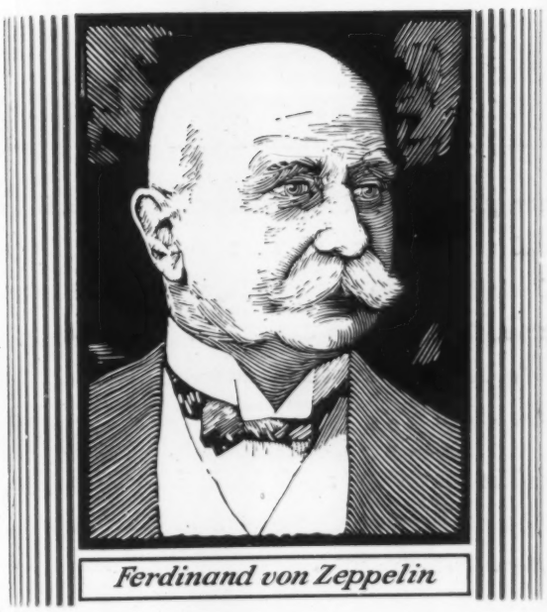
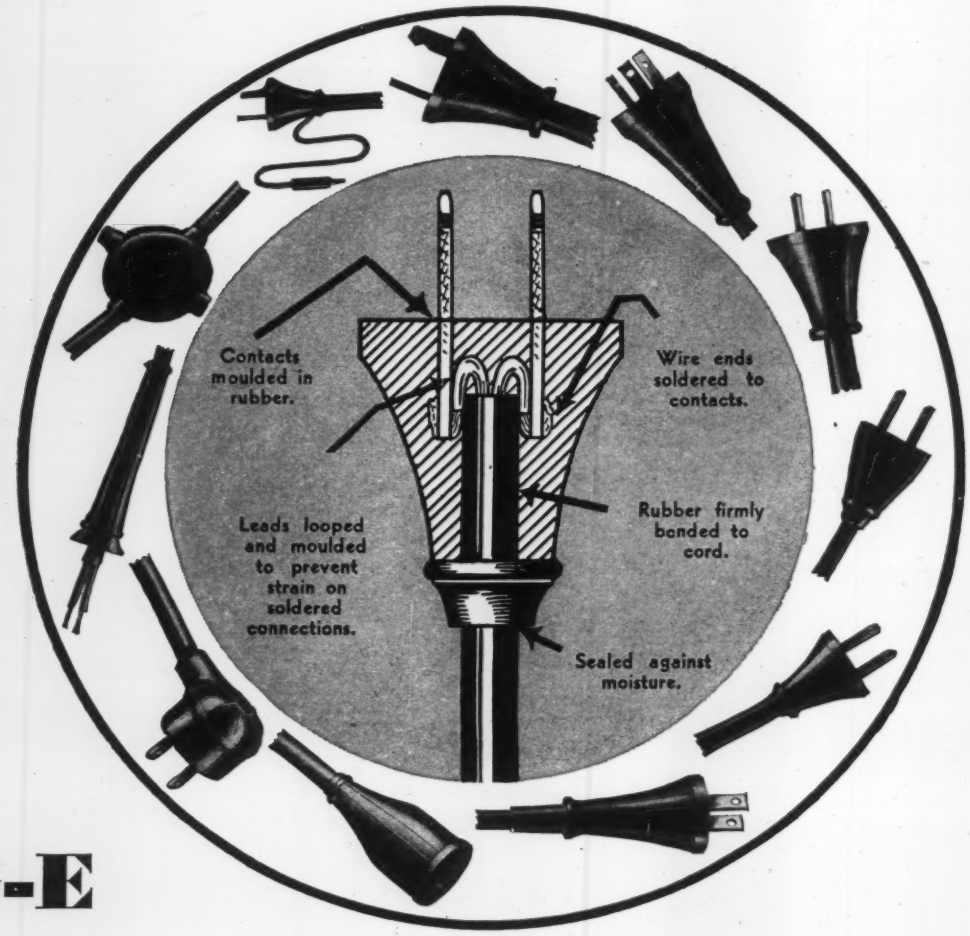
MACHINE DESIGN



Ferdinand von Zeppelin

AS IT AFFECTS

ENGINEERING—PRODUCTION—SALES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MACHINE DESIGN

FRANKLIN H. JOHNSON
Publisher

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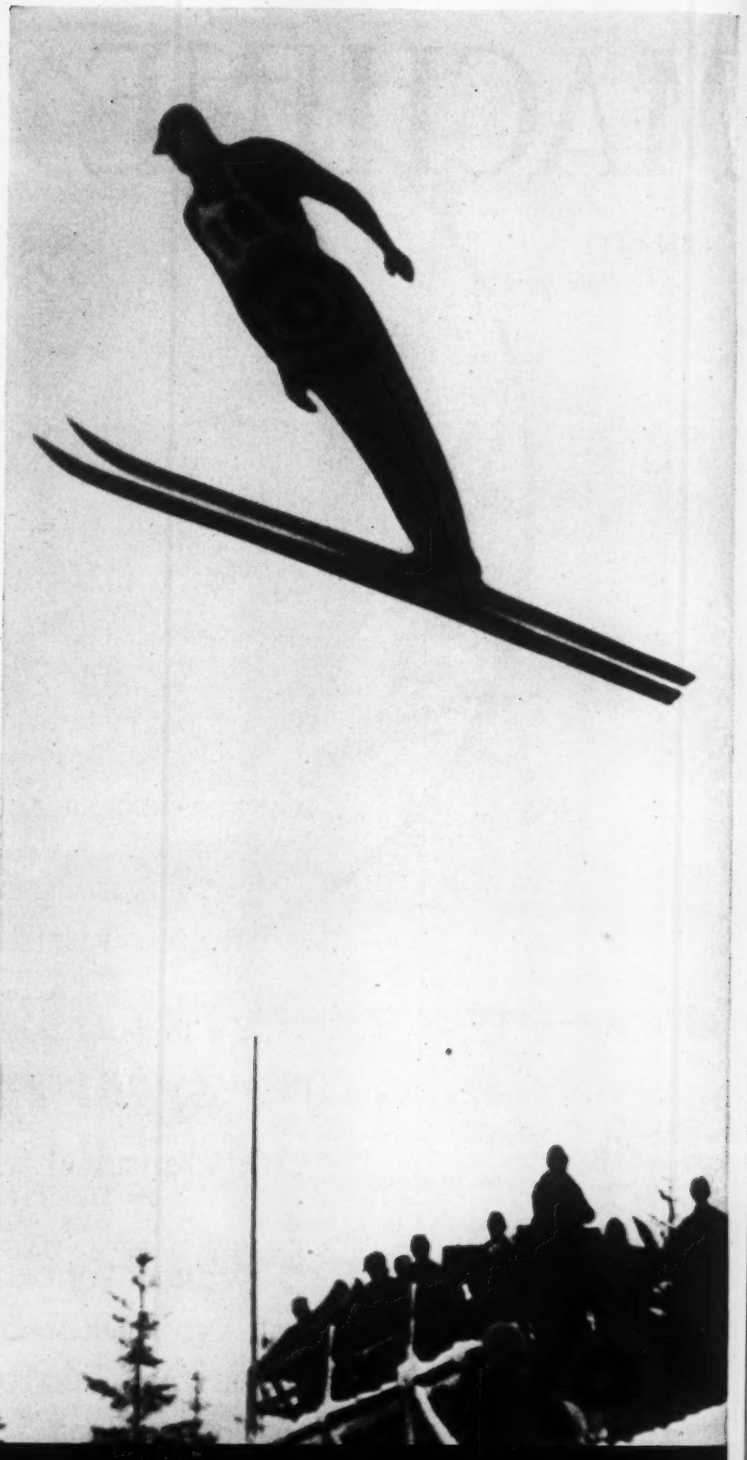
THE JOHNSON PUBLISHING CO.
Penton Bldg. Cleveland, O.
Affiliated with The Penton Publishing Co.

Branch Offices: New York, 220 Broadway; telephone Cortland 7-4594. Chicago, 1118 Peoples Gas Bldg.; telephone, Harrison 7506. London, The Penton Publishing Co. Ltd., 416 Caxton House, Westminster, S. W. 1.

Machine Design is published on the tenth of each month. Subscription rates: United States and possessions, Cuba and Mexico, two years $5; one year $3. Single copies, 35 cents. Canada, two years $6; one year $3.50, including duty. Great Britain and other European countries, two years, £1.13.6; one year £1.0.0. Copyright, 1934 by The Johnson Publishing Co.



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NEW DEPARTURE

BALL BEARINGS

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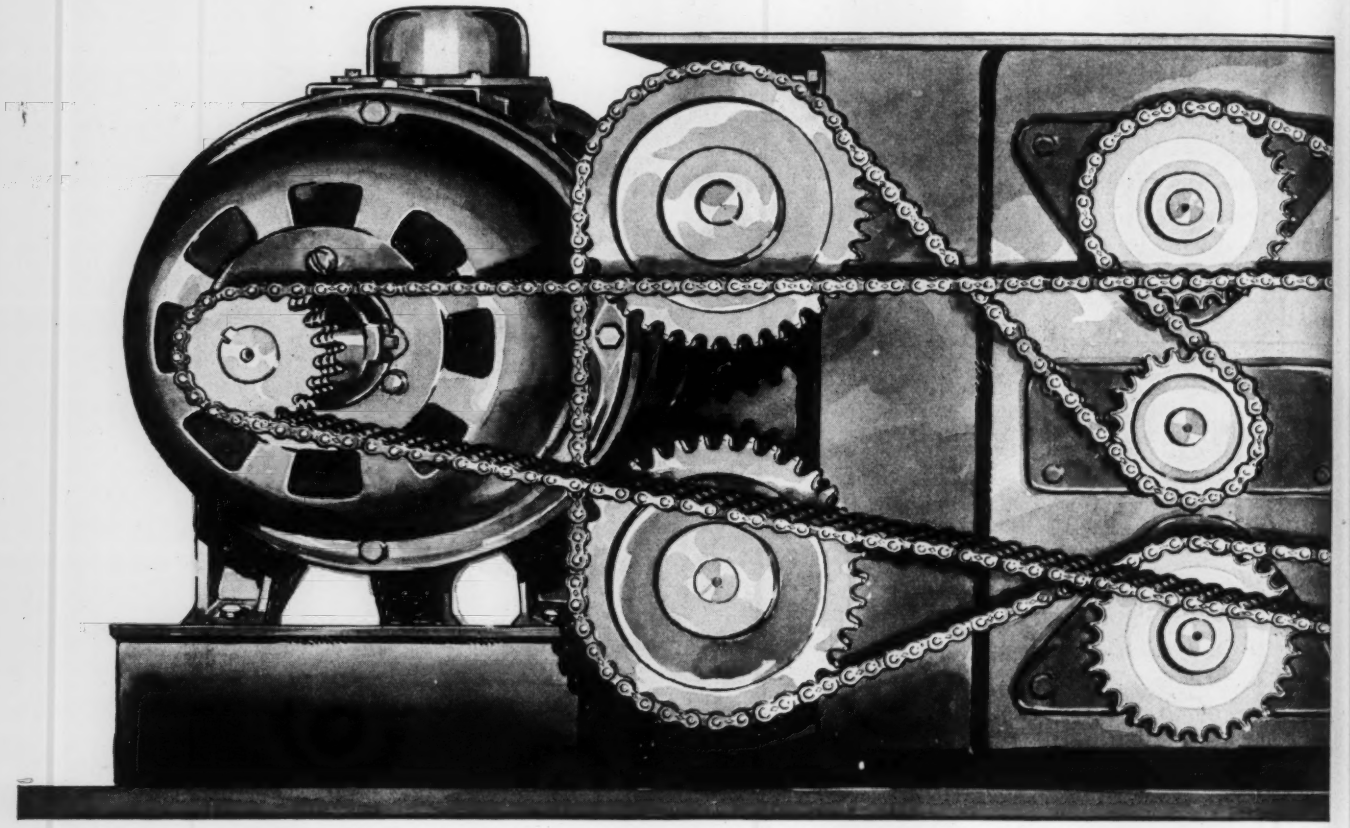
CHAIN DRIVES



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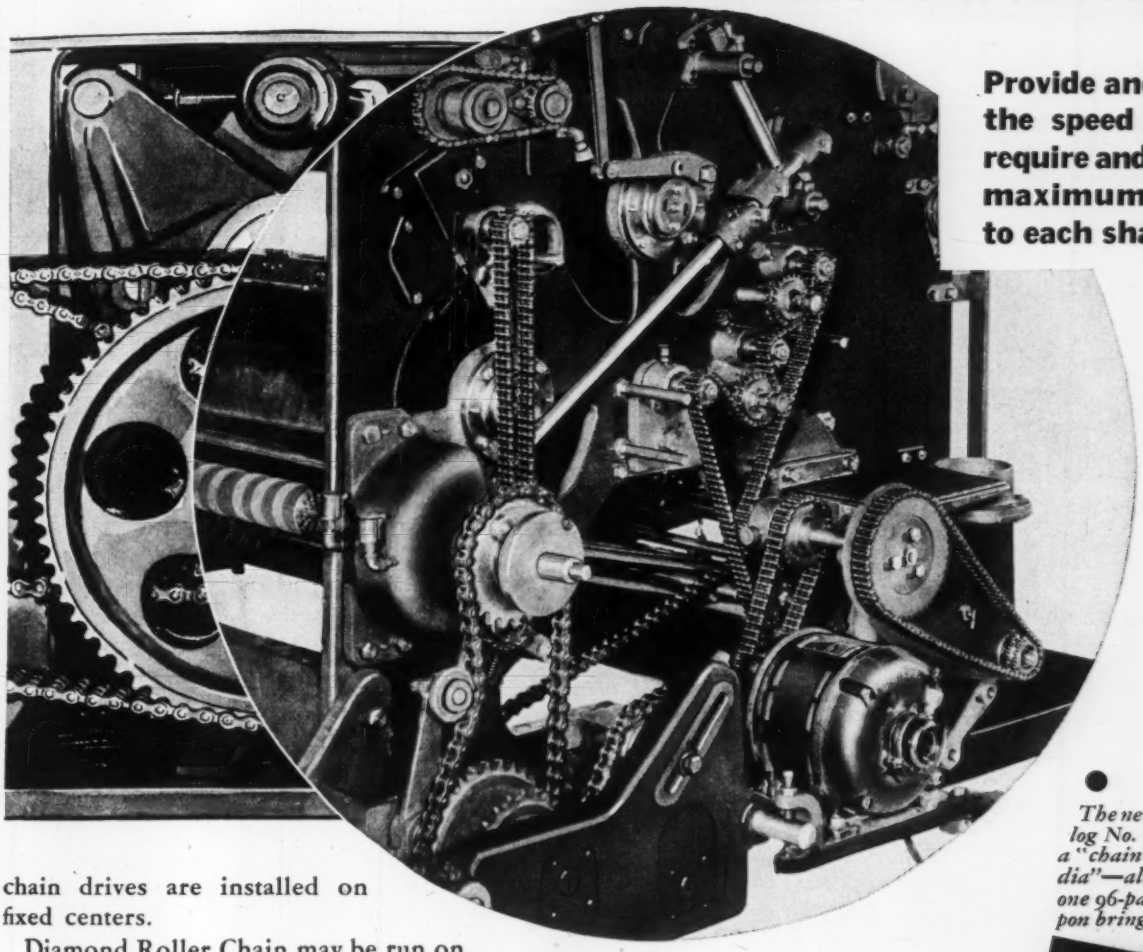

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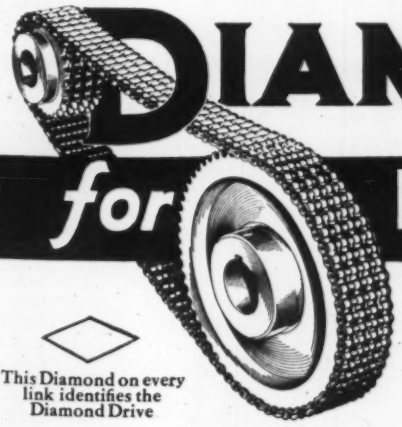

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(B-556)

CALENDAR OF MEETINGS AND EXPOSITIONS

Feb. 15-March 15—

Industrial Arts Exposition.

National Alliance of Art and Industry is sponsoring this exposition to be held at RCA building, New York. Alan Bement, 30 Rockefeller Plaza, RCA building, New York, is secretary of the organization.

Feb. 19—

Technical Association of the Pulp and Paper Industry.

Annual meeting and exposition to be held at Waldorf Astoria hotel, New York. R. C. Macdonald, 370 Lexington avenue, New York, is secretary of the association.

Feb. 19-22—

Coin Machine Exposition.

Sponsored by Coin Machine Manufacturers association, this exposition will include machines and parts. It will be held at Hotel Sherman, Chicago. Information on the exposition may be obtained from J. O. Huber, secretary, Coin Machine Manufacturers Association of America Inc., with headquarters in Chicago.

Feb. 19-22—

American Institute of Mining and Metallurgical Engineers.

Included in the papers to be presented at the annual meeting in Engineering Societies building, New York, are: "Internal Stresses in Quenched Aluminum and Some Aluminum Alloys," by L. W. Kempf, H. L. Hopkins and E. V. Ivanso; "X-Ray Study of the Action of Aluminum during Nitride Hardening," by John T. Norton; "Chromium-Nickel Steels Containing Columbium," by F. M. Becket and R. Franks; "The Determination of Oxygen in Alloy Steels and Its Effect upon Tube Piercing," by Newell Hamilton; and a Round Table on Nonferrous Metals in the Electrical Industry. A. B. Parsons, 29 West Thirty-ninth street, New York, is secretary of the society.

March 4-11—

Leipzig Trade Fair.

Exhibits of machinery from twenty-two countries will be included in this annual exhibition to be held at Leipzig, Germany. American headquarters are Leipzig Trade Fair Inc., 10 East Fortieth street, New York.

March 13-14—

American Railway Engineering association.

Annual meeting to be held in Chicago. E. H. Fritch, 59 East Van Buren street, Chicago, is secretary of the association.

March 5-9—

American Oil Burner association.

Eleventh national oil burner show to be held at Commercial Museum, Philadelphia, will include operating exhibits. Annual meeting of the association to be held at Benjamin Franklin hotel, Philadelphia. Harry F. Tapp, 342 Madison avenue, New York, is secretary of the association.

March 13-16—

Fourth Packaging, Packing and Shipping Exposition.

Annual display of equipment for modern packaging, packing and shipping to be held under the auspices of American Management association at Hotel Astor, New York, will include exhibits of materials, packaging equipment, machinery and supplies including bottle filling, gum taping, wire stitching and sealing machines, also packing and shipping room accessories, transportation and delivery essentials. John G. Goetz, 20 Vesey street, New York, is managing director of the management association.

March 26-30—

American Chemical society.

Semiannual meeting at St. Petersburg, Fla. Dr. Charles L. Parsons, 728 Mills building, Washington, is secretary of the society.

May 1-4—

Chamber of Commerce of the United States.

Annual meeting to be held at Washington. D. A. Skinner, 1615 H street, N. W., Washington, is secretary of the chamber.

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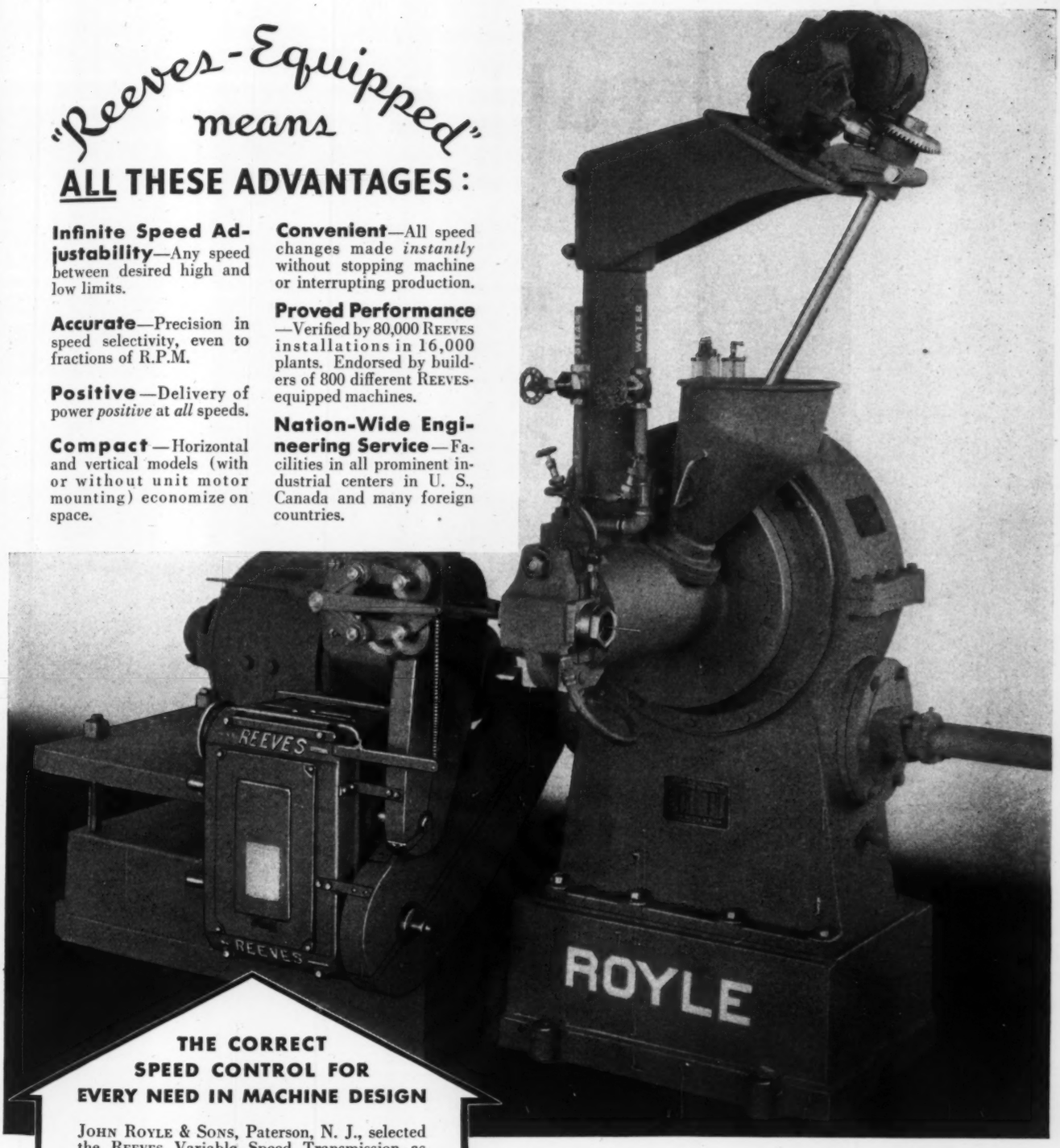

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MACHINE DESIGN
THE JOHNSON PUBLISHING CO., CLEVELAND, OHIO
February, 1934 Vol. 6—No. 2

Harnessing Fifty Thousand Revs per Minute

By Arthur Ayres
Chief Engineer, Sharples Specialty Co.

HIGH speed operations, always interesting design problems, take on added importance when the high speeds are used in connection with centrifugals, operating at extremely rapid rates and developing considerable centrifugal force which must be controlled in the design. Relatively high spindle speeds have been attained in grinder work, where the rotor is capable of being well balanced, bearings may be widely spaced, and inertia is slight. Doubtless specific problems exist in this work, but they are not analogous to those of the centrifuge.

The centrifugal rotor is a unit through which liquid is fed and in which solids are collected. In normal operation a certain amount of unbalance develops due to uneven deposition of the solids. This unbalance is increased by careless cleaning and by mechanical injury to the parts, such as is almost inevitable in service. The mounting cannot, therefore, be made rigid, but must be sufficiently flexible to absorb reasonable out-of-balance without distress,

Fig. 1—Proper lubrication of a vertically mounted bearing assembly becomes increasingly difficult as speed is increased

and must permit of operation above the critical speed; this requires that the rotor shall be allowed to assume a position such that the center of rotation is the center of mass.

The proper lubrication of a vertically mounted bearing assembly, never particularly simple, becomes increasingly difficult as speed is increased. To attain the higher speeds we cannot consider the use of grease packed bearings, nor may we arrange for the bearings to run fully or partly immersed in oil without excess power demand. Sight feed lubrication is also unsatisfactory, since at higher speeds a ball bearing will throw itself dry between drops, and the bearing life is materially shortened thereby.

Because of the inertia of the centrifugal rotor, proper consideration must be given to the length of the starting period, since the utilization of too rapid a start may result in mechanical damage, while an attempt to prolong the period may result in motor burnout. Adequate torque is required in order to bring the centrifugal ultimately to its speed, so motor starting devices that will sacrifice this torque cannot be used. The inertia also presents the need for satisfactory braking equipment to stop the unit within a reasonable time, and makes essential some point of failure that will permit the rotor to continue to turn after a bearing has failed and seized.

Shape of the rotor must be such there is ample provision for grinding to permit it to be put in good balance, and this provision must be made as near each end of the rotor as can be arranged, since only dynamic balance is acceptable.

Collection of the liquid delivered from the rotor may seem easy, but it must be kept in mind that at the higher speeds the liquid leaves the bowl at tremendous velocity and it is a finely atomized mist rather than a solid stream. The centrifugal separation is useless if there is any danger of a remixing of the discharging liquids before they are delivered from the machine, and such danger is great because of the high velocity air currents engendered by the rotor. These currents will vary in pressure with the diameter of each portion of the rotor, and additional air is entrained with the liquid being treated, so that the amount of blowing varies with the proportions of discharge. The only satisfactory way in which to assure relatively uncontaminated liquids is to utilize the air currents that exist and to direct them so that they will be friendly rather than unfriendly.

Maximum Force Applied

The solution of some of the problems outlined in the foregoing can be understood by considering the design of a small centrifugal, *Fig.* 1, developed by Sharples Specialty Co., Philadelphia. This unit is built primarily for technical laboratories where samples of material are to be studied through the application of the maximum possible centrifugal force. The rotor, *a*, Fig. 3, has an inside diameter of 1¾ inches, is 8 inches long, and is normally operated at speeds up to 50,000 revolutions per minute, thus developing a centrifugal force of 62,000 times gravity.

The top of the rotor is fastened permanently in place and is provided with discharge ports *b* and *c* through which separated liquid is drawn off. Ad-

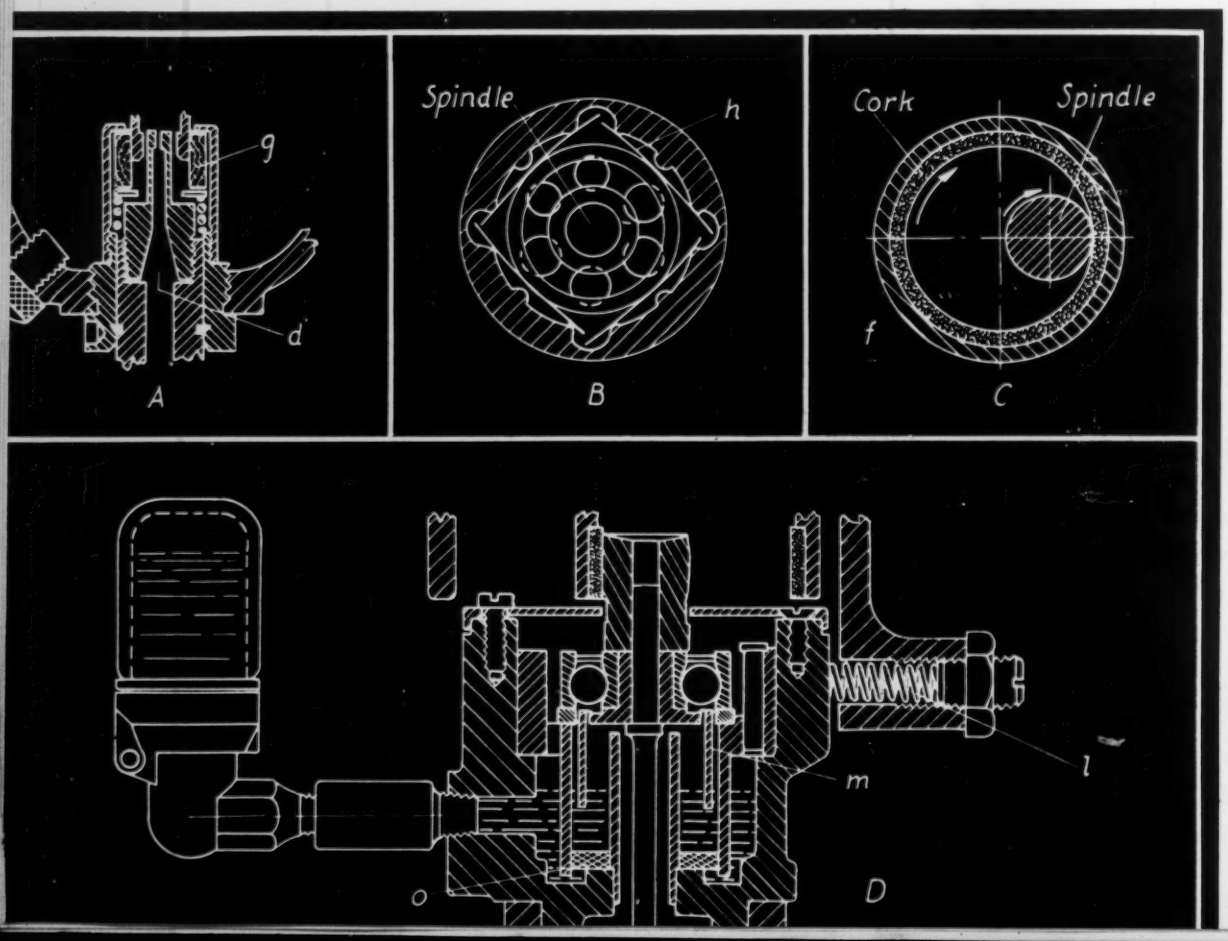

Fig. 2 — Unique bearing assemblies are employed to support rotor and provide for possible unbalance

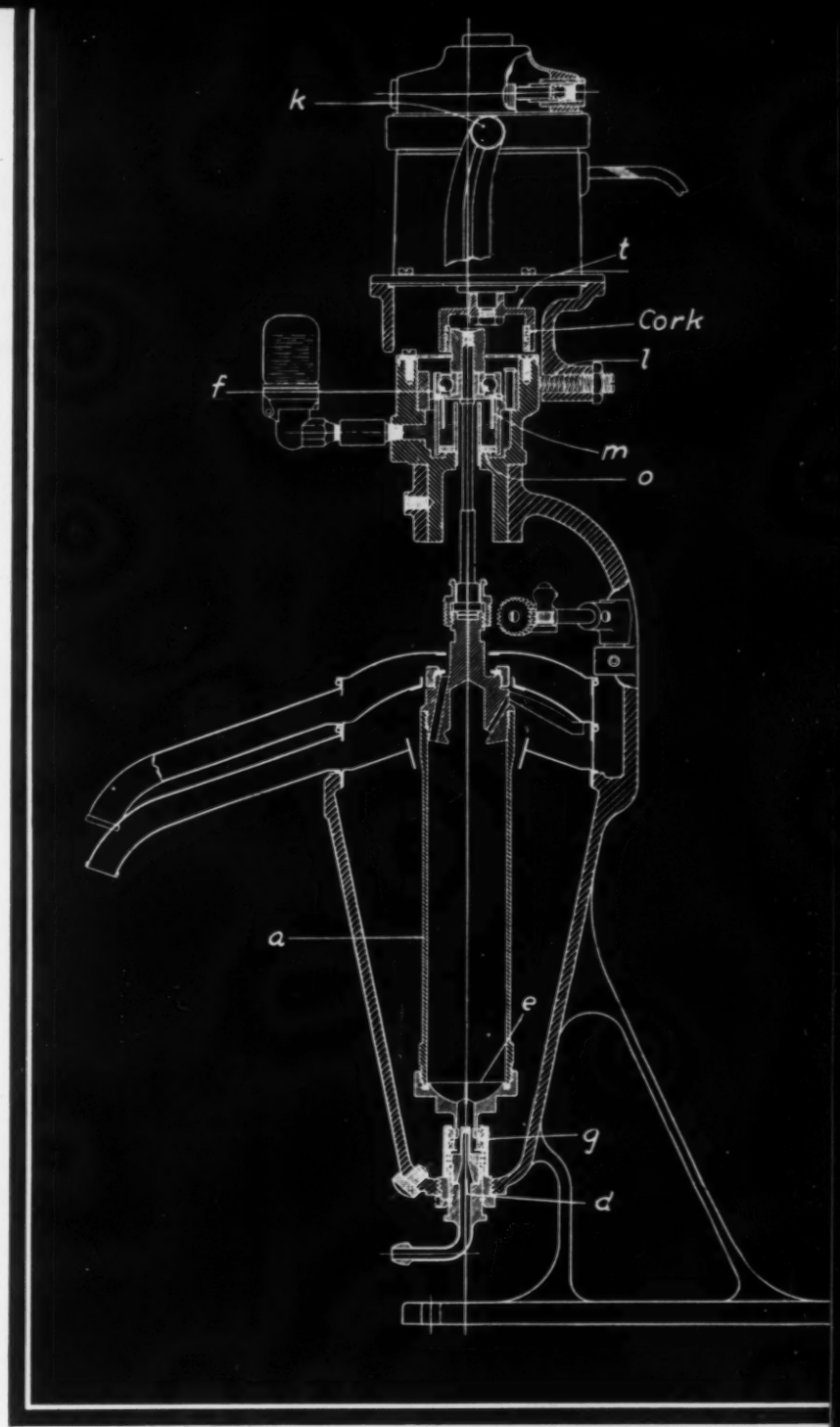

Fig. 3—Rotor is driven through a friction pulley by a series wound motor, and spindle is recessed to permit flexing

justable orifices are employed on the heavy side to create a correct separation regardless of specific gravity differences. The bottom of the rotor is removable so that accumulated solids may be cleaned out at the end of the run. Liquid to be separated is jetted into the bowl through a central opening, *d*, in the bottom, being brought up to speed by a series of wings, *e*, that cross this aperture.

Guide Bushing Steadies Rotor

The top of the rotor is connected by means of a spindle to the inner race of a ball bearing, while the lower end enters a guide bushing in what is known as the "drag" assembly, *Fig. 2A*. This bushing, *g*, can hardly be considered a bearing. When new it has an initial clearance around the bowl boss, and it operates satisfactorily up to about 1/32-inch wear in diameter. It merely acts to steady the lower end of the rotor when it is at speed. Inasmuch as some of the loads may be unbalanced, it would be impossible to fix this bushing rigidly in alignment with the geometrical center because, above critical speed, the rotor will tend to move over so as to make its center of rotation the center of mass. Clearance therefore is provided around the outside, and spring pressure is exerted beneath so as to prevent chattering but still permit the part to slide in any direction that the bowl requires in order to achieve true rotation.

It is apparent that a shifting of the rotor at such a time will tend to distort the spindle at each revolution, so the spindle is made quite flexible, being necked down to a small diameter near the top. The proportioning of the spindle diameter to the load is a matter requiring considerable study, since too light a spindle may permit fluttering and too heavy a spindle will result in overloading the bearing. As the spindle flexes it tends to throw a side thrust into the bearing assembly, *Fig. 2D*, and it is therefore standard practice to place a spring support around the ball bearing, Fig. *2B*. In this design the resiliency is provided in the simplest form, consisting of four flat springs, *h*, that are supported only at their ends with the center portion of each spring bearing against the outer race.

The bowl is driven through a friction pulley, *f*, *Fig. 3*, by means of a series wound motor. This type of motor was selected because a speed of 10,000 R.P.M. is possible, thus giving a moderate speed ratio, and because the speed of such a motor is determined by the load. The motor accelerates slowly and smoothly, bringing the rotor up to full speed in about 30 seconds. A fixed speed motor would tend to accelerate so rapidly that slippage might result at the friction surfaces. If gears were substituted, a motor of the proper horsepower might burn out before the rotor reached full speed. Over motoring will overcome this difficulty, but with this provision the unit will accelerate too rapidly for the mechanical safety of the centrifugal parts.

The design of the drive, *Fig. 2C*, is a simple one. The motor is pivoted at *k*. Contact between the cup on the lower end of the motor and the knob on the top of the spindle is created by

the tension of spring *l*. The driving cup is faced with cork.

Earlier tests on this machine were made with a lubricating system consisting of the conventional sight feed oiler, with oil flowing through the bearing and delivered to waste. Bearing life was relatively short and it was found that the bearings were running dry between drops of lubrication. It was obvious, after each bearing failure, that they were entirely too free of oil for satisfactory operation. The present continuous method of oiling was therefore designed. Its adoption has increased the bearing life by over 20 times.

It can be seen in *Fig. 2D* that there is a well beneath the bearing where a constant oil level is maintained by a bottle type oiler. An annular extension, *m*, that rotates with the spindle, dips into this oil supply. The inside bore of this extension carries a ½-degree angle. At the speed of rotation this angle is sufficient to lift oil and deliver it through small holes into the under side of the ball bearing. Excess oil overflows the top and is carried through holes into an outside portion of the reservoir from which point it reenters the lubricating section through a piece of felt, *o*, which removes any impurities and keeps the oil in good condition. This guarantees continuous lubrication at all times and reduces oil consumption practically to zero, the only loss being vaporization. It was found necessary to baffle the oil well intricately so that rotation would not be induced in the body of oil, resulting in leakage down the spindle.

Must Control Blowing

As stated in the foregoing, it is imperative that the liquid being discharged into the covers, *p* and *r*, *Fig. 3*, be delivered through their spouts to the outside without recontamination. The blowing engendered by the rotor will, unless controlled, cause a suction around the neck of the bowl, with the major portion of this air being exhausted from the lower cover spout. The reason for this should be clear, since there is a larger area of rotor blowing into the lower than into the upper cover. There also is a tendency for a certain amount of air to be drawn out of the lower cover into the frame beneath, since the large diameter of the bowl is tending to cause a partial vacuum at the center. Such communication of air will carry vapor with it, with the result that there will be a mixture of the upper liquid with the lower and a loss of some of the lower liquid into the frame.

It will be noted that there is a cone-shaped piece *s*, inserted at the center of the lower cover, with the angle so arranged that any blowing of the bowl against that cone will have an upward resultant which nullifies the downward tendency. A cone such as described cannot be installed in the upper cover because it will obstruct the liquid discharging into the lower. Therefore, other means must be utilized. They consist of a series of wings placed tangential to the center opening of the upper cover and in such position that blowing against them will result in an upward draft, thus counteracting the tendency toward downward leakage. It is apparent that a device of this kind might be sufficiently powerful to reverse the air currents and thus cause remixing in the opposite direction, so the proportions must be studied carefully for each type and speed of centrifugal.

Little need be said about the construction of the rotor itself. Additional metal is left on the shell at the top and bottom, next to the threads, to provide material for grinding at the time of balance. The shell must, of course, be of ample strength to provide a generous factor of safety under the stresses developed. It is of high carbon seamless steel tubing.

In spite of the problems that required consideration, it will be noted that the ultimate design is one of extreme simplicity. To a large extent that may be taken as a measure of good engineering.

They Say—

"A raised standard of living can only come as a result of an increased spread between wages and prices, by raising wages relative to prices. The extent to which this can be done is limited unless we apply the tried and tested method—the direct and obvious method—that of improved processes, organization and machinery. There is no other way."—Ralph E. Flanders.

□ □ □

"Engineers must discourage the present movement to replace machine processes by hand labor. During recent months an effort has been made to decry capital expenditures, to urge the substitution of human and animal labor for mechanical power and machinery, and to hinder economical methods of production. The present will not be improved and the future will be greatly impoverished if this type of thinking prevails."—A. A. Potter.

□ □ □

"One of the reasons for the low-cost production of new cars is the adoption of speedier and more efficient tools and equipment, which builders have taken the opportunity to perfect during the lull since 1929. The refrigeration and washing machine industries, both of which enjoyed a sharp sales increase last year, also installed new equipment. These industries are an excellent example of cost reduction through improved equipment and the consequent tapping of new, lower purchasing power markets."—Herman H. Lind.

SCANNING THE FIELD FOR IDEAS

GOOD APPEARANCE EFFECTS SALES

ULTIMATELY the sales record of a design must be taken as the measuring stick of its success. The user's stamp of approval consequently is the aspiration of all enterprising designers. Assuming of course that the design engineer is well aware of the importance of mechanical efficiency, his next essential step is the consideration of eye appeal. These columns frequently have presented specific examples wherein the combination of the two were reflected in public acceptance. Again attention is called to this important question through a brief discussion of the new protectograph redesigned by Henry Dreyfuss for the Todd Co., Rochester, N. Y.

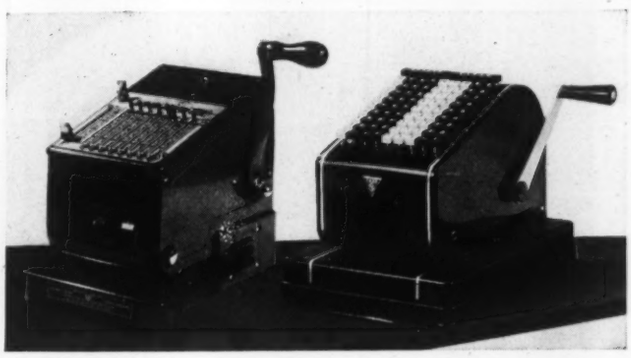

Fig. 1—Changes to improve appearance of old protectograph (left) resulted in higher mechanical perfection of new model (right)

In the left hand view, *Fig.* 1, is shown the previous model, with the new design at the right. By observing what has been accomplished through redesign, it readily can be seen why the company is receiving enthusiastic reports from its customers. Keys have been substituted for levers and incidentally the square type key is a radical innovation. Tests prove they are easier to use. "Repeat" and "Clear" bars are in keeping with the square keys and also are less difficult to operate than the small buttons that were planned originally.

Front and back pieces are removable, the trade mark on the face of the panel acting as a latch for the front piece. A small inconspicuous bar near the top of the back piece serves as a latch for this section. Changing of the ribbon and accessibility of the interior mechanism thus are facilitated.

Keys are gray and black, set off by a red background. The case has graceful lines with narrow silver strips running down either side of the unit and on to the base to tie the two units together. The fact that all visible screws have been eliminated is another noteworthy feature.

CLUTCH UTILIZES ROLLING ACTION

ROLLING action, always a desirable mechanical characteristic, has been substituted for rubbing friction in the new Borg & Beck clutch, *Fig.* 2. It will be noted that each release lever *A* is pivoted on a floating pin which remains stationary in the lever and rolls across a short flat portion of the enlarged hole in eyebolt *C*. There

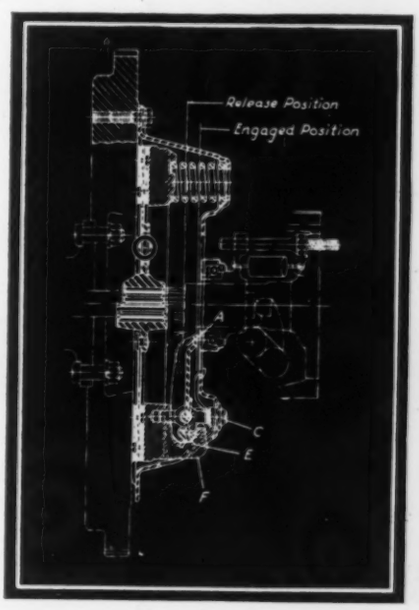

Fig. 2 — Substitution of rolling action for rubbing friction was a major objective in the design of this single plate dry disk type clutch

is enough clearance between the pin and the eyebolt to permit complete release of the clutch before the pin has rolled from the further side of the eyebolt hole across the flat to the inner side of the hole.

At the outer end of lever *A*, direct contact with the lug on the pressure plate *F* with resultant sliding friction, is eliminated. A 3/32-inch thick blade having rounded edges, acts as a strut *E* under compression to transfer the load from the lever to the lugs on the pressure plate. This blade, riding in a groove of larger radius in the lever, has a combined rolling and sliding action, but the resultant friction and wear are negligible because the blade is thin and presents a knife edge action on the lever.

WIDER USE FOR MAGNETIC MATERIAL

COBALT steel, an unusual magnetic material developed by P. H. Brace, Westinghouse research laboratories, is so powerful that a ring of the material can float itself on air by magnetic repulsion. Principal among its uses are in the all-electric speedometer for trains, buses and automobiles and in the portable oscillograph which enables engineers to determine easily stresses in various parts of machinery, track rails and structural members of buildings.

DRIVING BY A ROLLING WEDGE

TRANSMISSIONS offer a fertile field in which to exercise ingenuity and often one type of design will pave the way to an idea for another. Herewith is a rolling wedge drive that A. W. Redin & Son Machine Co., Rockford, Ill., is utilizing to obviate the use of belts and belt tension on a new drill. As illustrated in *Fig.* 3, a composition roller is held against the motor and spindle pulleys by a light spring. Because of the direction of rotation the roller wedge is drawn automatically between the two pulleys as resistance is applied to the drill spindle. Any speed can be selected at will and the change may be made while the motor is idle or running. Because of automatic pressure adjustment and the absence of vibration, the mechanism is claimed to be particularly easy on bearings.

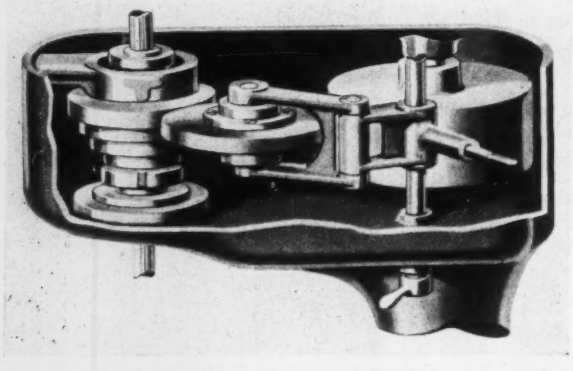

Fig. 3—*Nonmetallic roller acts as wedge to effect drive between motor and spindle pulleys*

LOCATING THE MOTOR TO ADVANTAGE

BECAUSE kitchen mixing machines have followed a more or less stereotyped design it is exhilarating to find a new one that departs from the conventional. Reference is made to the General Electric food mixer, *Fig.* 4. Outstanding is the fact that the motor is located in the base of the machine and a flexible shaft drive to the head employed. The first objective was the use of a motor of more power so that any of the attachments provided as standard equipment, or other attachments that might be developed later, could be operated easily without causing overload.

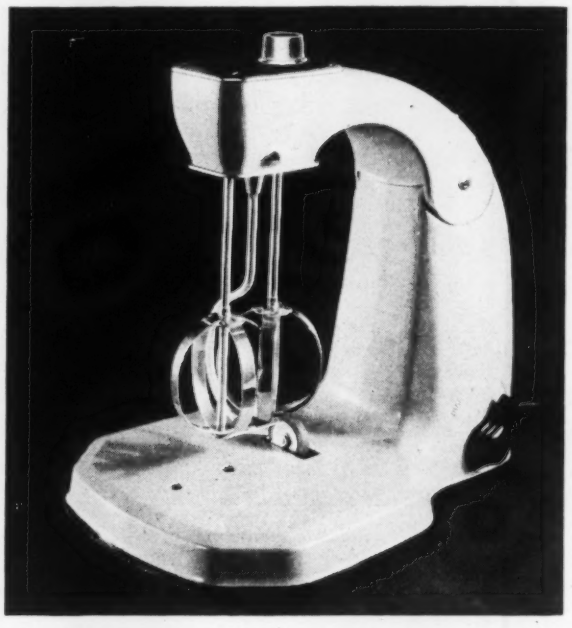

Fig. 4—*By locating the motor in the base of this food mixer gratifying results were obtained*

Other considerations which dictated the design lay in the fact that the gearbox in the head of the machine, to which the beaters are attached, is filled with heavy grease. In many of the earlier machines, heat from the motor rendered this grease sufficiently liquid as to cause it to drip out on the beaters. It was logical therefore, from this standpoint alone, to station the motor in the base.

Further, it was realized that by embodying

the motor in the base of the machine the center of gravity would be lowered, providing better stability. Added to these features, the location of the motor made it possible to design a bowl drive which would rotate the vessel at a constant speed irrespective of the consistency of the batter.

From an appearance standpoint as well the mixer commands attention. The clean design is free from corners and pockets in which dust and food particles might accumulate.

REDUCER GIVES CLOSE CONTROL

DESIGNERS confronted with the problem of attaining close variation in speed control might obtain an idea from a method employed by an airplane manufacturer. To change propeller pitch gradually a three-stage speed reducer built by Universal Gear Corp., Indianapolis, is utilized in a simple but unique way. The three propeller blades are pivoted on radial bearings and connected through bevel gears to a master bevel driven by a 1/6 horsepower reversible motor located in front of the propeller and bolted to the hub. Ratio of the speed reducer

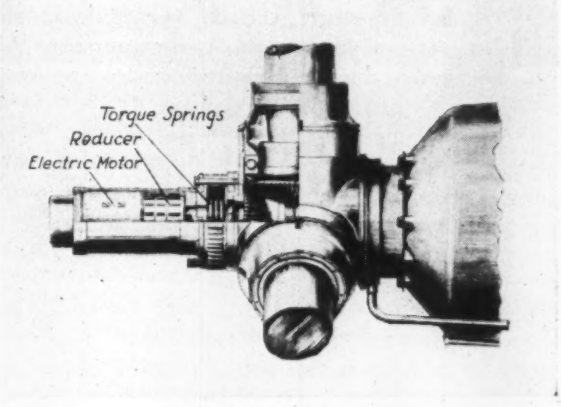

Fig. 5—Control of propeller pitch is obtained through use of motor and speed reducer

is 27,000 to 1, permitting gradual pitch change without complicated or bulky parts. Springs between the output shaft of the reducer and the three movable blades cushion the back torque occasioned by movement of the propeller in driving the plane. The idea is shown in *Fig.* 5.

RUBBER DISSIPATES VIBRATIONS

NOISE and vibration no longer need go uncontrolled. If they do, a lack of initiative on the part of the engineer is reflected. Consider for instance, a 5000-pound industrial blower, *Fig.* 6, cushioned by eight ½-inch strips of rubber and operating with barely a sound. That is essentially what has resulted from the use of Firestone vibration dampeners on this equipment.

In principle the construction of the dampener is simple. Cushion strips of tough, live rubber are bonded by a special process to plates of brass-

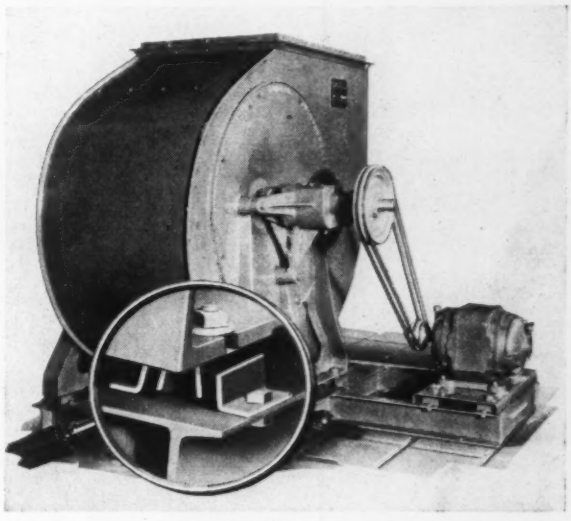

Fig. 6—Rubber in shear serves to dampen vibration and eliminate noise in machinery

plated steel. The rubber-metal cushion is bolted to the machine and to the floor, leaving the rubber strips in shear between the two plates. Lower curved contour of the rubber cushion is designed to contact with the base progressively for building up resistance to heavy loads and shocks by placing the rubber under compression.

Vibrations from the machine are dissipated and absorbed as the rubber yields under the shock, thus eliminating noise and protecting the machine. The same principle is used in cushioning automobile motors.

ALUMINUM EMPLOYED IN NEW ROLE

OF THE month's news in the world of materials one of the highlights concerns the discovery of a new type of reflecting surface with a base of aluminum. This was announced at a meeting of the Illuminating Engineering society at Cleveland recently. Aluminum finished by the new process has a reflectivity as high as 85 per cent, not far below that of silver. Advantages claimed include non-tarnishing in industrial atmospheres, resistance to weather and ease of cleaning with soap and water. Aluminum of the type commonly used for reflectors is too soft to lend itself to exceptional brightness by commercial polishing methods.

High Speeds I
Complicat S

By Edward K. Hankin

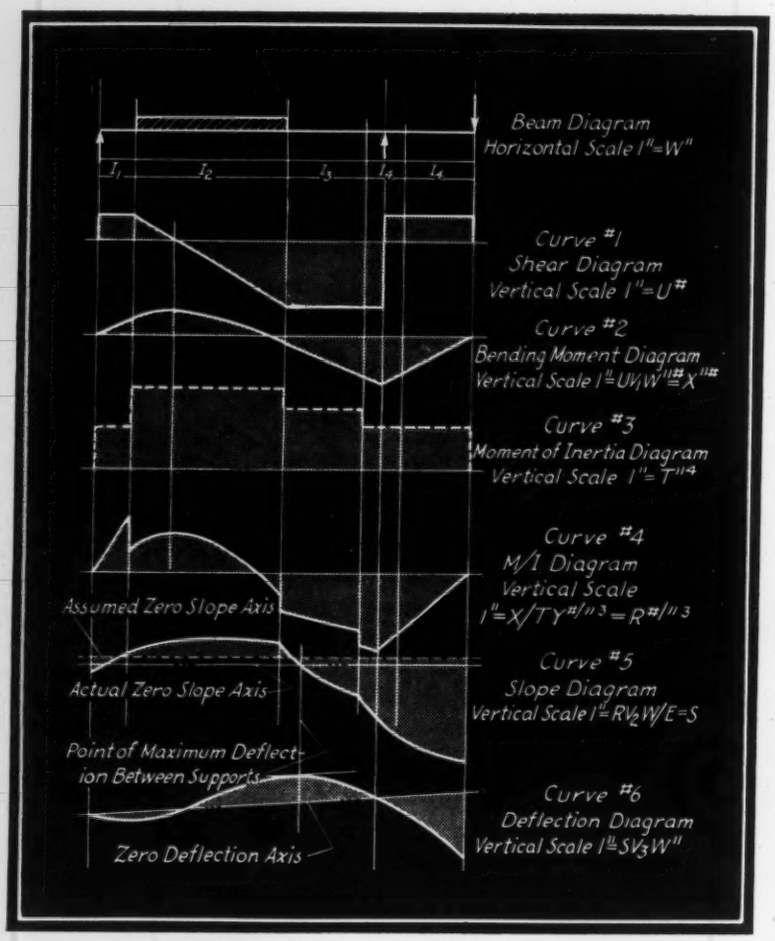

Fig. 1—Graphical method speeds solution of deflection problems

WITH the trend towards increased loads and speeds of bearings and cut gears, and the use of alloy steels at high unit stress, more thought is being given to the amount and effects of shaft deflection. Unfortunately, a great many of the shafts involved in such considerations are complicated, as varying diameters and irregular loadings are encountered. This, in turn, entails an analytical solution involving the use of integral calculus, a subject with which most designers are not sufficiently familiar.

To simplify this condition there has been developed a graphical solution for shaft deflection problems which has proved satisfactory in practice. The principle involved in the solution is not new, it merely being a matter of graphically performing the steps of the analytical method. However, as far as is known the method has not previously been evolved in this form. As the method presented involves the use of graphical division and graphical integration it might be well to note that data on these functions which are not generally known or used can be obtained from *Graphics* by R. H. Smith.

The obvious feature of this method is the elimination of the use of all mathematics except for the few simple calculations needed to determine the reactions and scales. Another feature is the form of the result which is a curve indicating the exaggerated shape of the shaft and giving the actual deflection of every point on the shaft and its direction to scale with reference to the supports. This makes it a simple matter to locate the point of maximum deflection and the amount, and to determine the deflection through a bearing, or across a gear face, or the relative positions of any other points on the beam that might be needed as design data. Intelligently used, the solution can be applied to practically every deflection problem where the external forces acting on a beam are known. While it appears to be rather lengthy, it is within the scope of most engineers, and really is much quicker than the analytical method even in the hands of a mathematician.

Convenient Scales Employed

Referring to *Fig.* 1, steps of the solution are, in general:

Draw the beam to a convenient horizontal scale, 1 inch$=W$ inches, and indicate loading and moments of inertia

Construct the shear diagram (Curve No. 1, *Fig.* 1) to the vertical scale of 1 inch$=$ U pounds

Graphically integrate the shear diagram, obtaining the bending moment diagram (Curve No. 2) to the vertical scale of 1

Increased Loads

Shaft Design

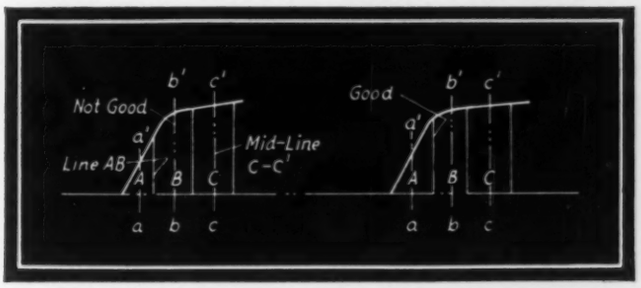

Fig. 3—Lines should be spaced so that the intercepts of curve midlines approximate mean curve height

inch $= UV_1W$ inch pounds $= X$ inch pounds

Construct the moment of inertia diagram (Curve No. 3) to the vertical scale of 1 inch $= T$ inches fourth

Graphically divide the bending moment by the moment of inertia and construct the M/I diagram (Curve No. 4) to the vertical scale of 1 inch $= X/TY$ pounds per cubic inch $= R$ pounds per cubic inch. Y equals the division pole distance

Graphically integrate the M/I curve, obtaining the slope or $(1/E) \times \int M/I$ curve (Curve No. 5) to the vertical scale of 1 inch$=RV_2W/E= S$. V_2 equals the integrading pole distance and E equals the modulus of elasticity of the material

Draw an assumed zero slope axis in such a position that, between the supports, the area between it and the slope curve above the axis is approximately equal to that area below the axis

Graphically integrate the slope curve about the assumed zero slope axis obtaining the deflection curve. Draw the zero deflection axis through the points where the deflection curve crosses the center lines of support. The vertical intercepts between this zero deflection axis and the deflection curve give the deflection to the scale 1 inch $= SV_3W$ inches. V_3 equals the integrating pole distance

If the actual zero slope axis is desired it should now be drawn so that it intersects the slope curve at the points of maximum deflection between the supports.

Should couples due to thrusts from helical or bevel gearing or similar forces be present besides the axial loads covered in the foregoing, the moment caused by these forces must be algebraically added to the bending moment diagram obtained by graphically integrating the shear diagrams as outlined in the following

Explains Graphical Integration

Graphical integration of a curve is the plotting of a second curve, the vertical intercepts of which represent, to a scale, the total summation of the area to the left of the intercepts under the first curve. To integrate a curve, referring to *Fig.* 2:

Cut the area under the curve into the number of area sections, *A*, *B*, *C*, etc. with lines *AB*, *BC*, *CD*, etc. which are perpendicular to the axis *O-O'*

Draw the lines *a-a'*, *b-b'*, etc. midway between the lines *AB*, *BC*, etc. Note—the lines *AB*, *BC*, etc. should be so spaced

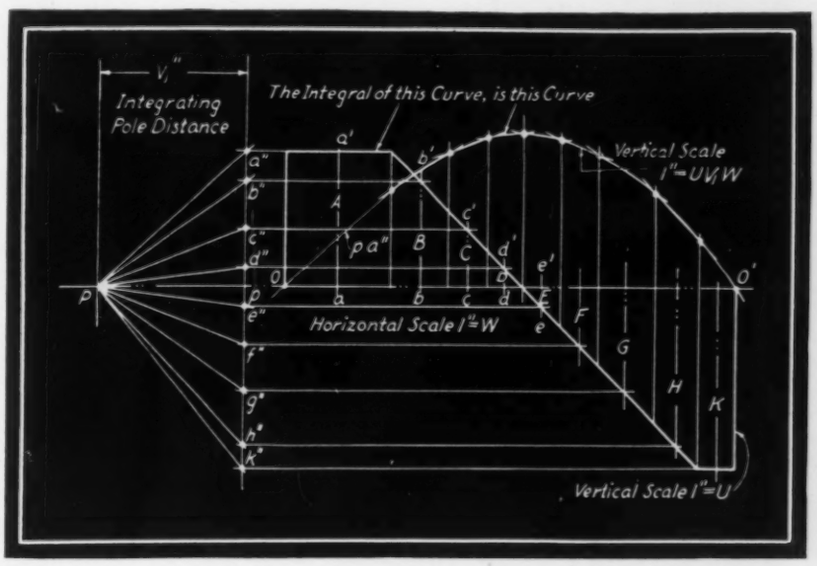

Fig. 2—Integration by graphics gives summation of the area under a curve

that intercepts of the curve on midlines a-a', b-b', etc. closely approximate the mean height of the curve between the lines as is shown in the right-hand section of *Fig.* 3

Now, project the heights of the intercepts on the midlines to a perpendicular erected at some point p on the O-O' axis, locating points a'', b'', c'' etc.

Locate point P along the axis some even pole distance V_1 from p and draw in rays Pa'', Pb'', Pc'', etc.

Through point O draw a line across area A parallel to ray Pa''. Through the point where this line intercepts line AB draw a line across area B parallel to ray Pb'', etc.

Through these points of the intersection of lines Pa'' and AB, Pb'' and BC, etc. draw a faired curve. This curve to the vertical scale of 1 inch$=UV_1W$ represents the *integral* of the *first curve*, where the vertical scale of the first curve was 1 inch$=U$. The horizontal scale of both curves is 1 inch$=W$, and the integrating pole distance equals V_1. The *unit* of the *scale* (1 inch $= UV_1W$) is equal to the product of the unit of U and the unit of W

Example—On the first curve, if 1 inch $= U =$ 1000 pounds, 1 inch$=W=2$ feet, and $V_1=2$ inches, then, on the second curve, 1 inch$=UV_1W=4000$ foot pounds.

Division May Be a Curve

When a division is to be performed to scale with the values of the dividend and division in the form of curves and the quotient is wanted in this same form, then the following method will be applicable. Such a case occurs in the problems of graphical determination of beam deflection where the divisor is a curve representing the values of the moment of inertia of the beam I, the dividend is a curve representing the values of the bending moment M on the beam, and a curve representing the values of the quotient M/I is wanted.

To make this division the following steps, as shown in *Fig.* 4, must be followed.

Erect a perpendicular p-p' at some point p on the O-O' axis and measure off some even pole distance Y to locate the point P. If Y is made shorter than the lineal value of the divisor, then the lineal value of the quotient will be less than the lineal value of the dividend at that point.

Measure back to the scale 1 inch$=T$ along the O-O' axis from point P a distance equal to the first value of the divisor locating point m. Here erect the perpendicular m-m'

Project the values of the dividend to the scale 1 inch$=X$, which is to be divided by this first divisor on to the perpendicular m-m', locating point a'

Now through points a' and P draw a ray intersecting the perpendicular p-p' at point a''

Then the intercept p-a'' is the value of the quotient to the scale 1 inch$=X/TY$. The

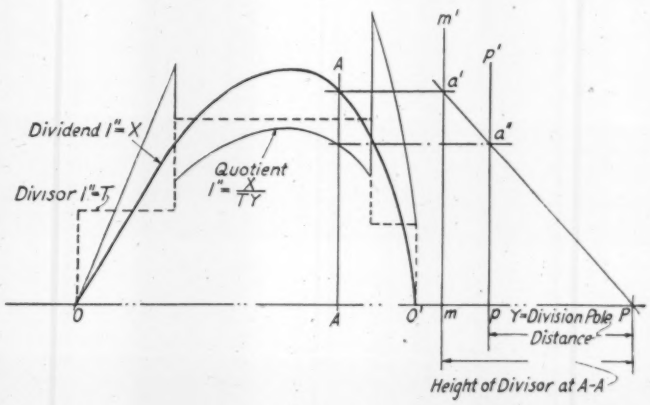

Fig. 4—Graphical division simplifies computations

unit of the scale of the quotient (1 inch$=X/TY$) is equal to the unit of the scale of the dividend (1 inch$=X$) divided by the unit of the scale of the divisor (1 inch$=T$)

Example—If the scale of the dividend were 1 inch$=X=4000$ inch pounds, and the scale of the divisor were 1 inch$=T=4$ inches fourth, and the pole distance $Y=4$ inches, then the scale of the quotient would be 1 inch$=X/TY=$ 4000 inch pounds$\div 4 \times 4$ inches fourth$=250$ pounds per cubic inch.

Smooth Curve Preferable

The second step must be performed once for each value of the divisor, each time erecting another perpendicular m-m'. The third and fourth steps must be performed for each value of the dividend or for each point required so that a smooth curve can be drawn to represent the quotient.

The method described in the foregoing should be used only when the number of values of the divisor are few in relation to the number of values of the dividend. Should this condition be reversed, then the method should be changed to take care of it.

Outstanding Patent Book Revised

Production Handbook, Cast Iron Symposium Augment Book List

Inventions, Patents and Trade-Marks

By Milton Wright; published by McGraw-Hill Book Co. Inc., New York; available through MACHINE DESIGN *for* $2.50 *plus* 15 *cents postage.*

With our changing industrial order come new problems created by more highly competitive markets which will challenge the keenest minds. An increase in patent questions is inevitable due to far-flung effort on the part of companies and their employes to preserve individuality and identity. Therefore, the second edition of this book meets an acute need. It provides the manufacturer as well as the individual with information needed in obtaining, preserving and using exclusive rights to property.

Revision of the volume has amplified the contents and brought it up-to-date. Changing laws, regulations and economic conditions have been responsible for the addition of considerable material. It is significant that the opening chapter covers "Protection and the New Deal." Other pertinent sections are devoted to the field for invention, the question of taking out a patent, plant patents, the inventor and his employer, value of a patent, etc.

One of the most interesting chapters is entitled "One Hundred Questions on Protection." Here may be found answers to many important matters that frequently arise. The chapter on plant patents has been inserted to cover a law that has been passed since the previous edition was written.

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Cost and Production Handbook

Edited by L. P. Alford; published by Ronald Press Co., New York; available through MACHINE DESIGN *for* $7.50 *plus* 15 *cents postage.*

Because design and production bear an intimate relation it is natural that MACHINE DESIGN should lay particular emphasis on the importance of this new handbook, heralded as the world's first. Assisting the editor was a board of 80 authorities among which appear many names prominent in the engineering profession. In the 1544 pages may be found data covering reports, budgets, production planning, material costs, labor costs, plant and equipment costs, control of manufacturing costs and auxiliary methods for effective manufacturing.

In the section devoted to development and research are treated such topics as organization as applied to various phases of engineering and research in the plant. A portion of the discussion is devoted to the set up of a machine design department. The text matter also analyzes the problem of evaluating research ideas.

The foregoing, coupled with the broad consideration of production factors, provides an assembled and comprehensive study of timely problems. Every engineer charged with design responsibility will find this book particularly helpful in broadening his understanding of modern manufacturing management.

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Symposium on Cast Iron

Prepared by a joint committee of the American Foundrymen's association and the American Society for Testing Materials; available through MACHINE DESIGN *for* $1.00 *plus* 15 *cents postage.*

Since selection of materials comprises one of the vital factors in successful design, those responsible for the creation of machines must keep abreast of developments in the field of metals. To bring up-to-date information on cast iron this symposium was published. It is a compilation and critical interpretation by experts, of data on the production and use of this material. Subjects covered include properties, specifications, heat treatment, welding and foundry factors of importance in production.

An advisory committee, including in its personnel outstanding authorities, was appointed by the two societies to supervise the symposium. In the 164 pages comprising the book may be found much data directly pertinent to design.

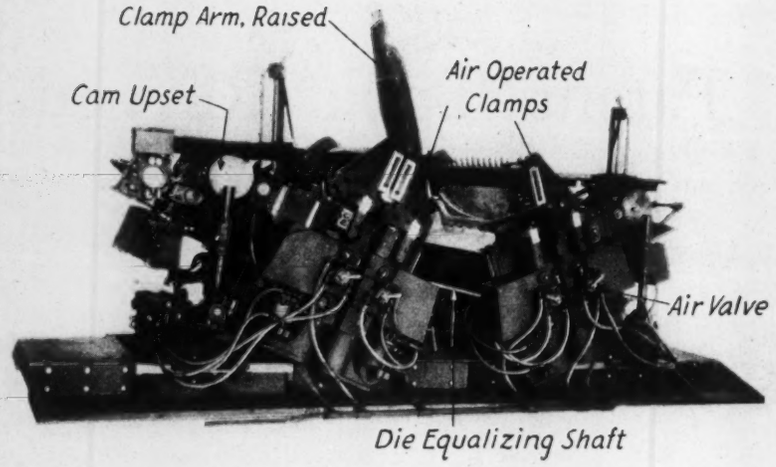


Fig. 1—Electrical devices and mechanisms constitute the basis for design of this resistance flash welder for automobile bodies

Electricity Dominates Design of Auto Body Welder

By Harold B. Veith

Associate Editor, Machine Design

ELECTRICAL resistance flash welders such as those used in the production of automobile bodies involve a combination of mechanical and electrical principles that is relatively unique in the design of machinery. Mechanically these units incorporate movements that are common to many types of machines. In addition, however, there are electrical calculations to be considered. For example the parts carrying electric current must be calculated for a capacity of approximately 30,000 amperes; it therefore is imperative that their cross sectional area be sufficient to carry the load. This factor brings in the matter of insulation through such materials as bakelite. Any

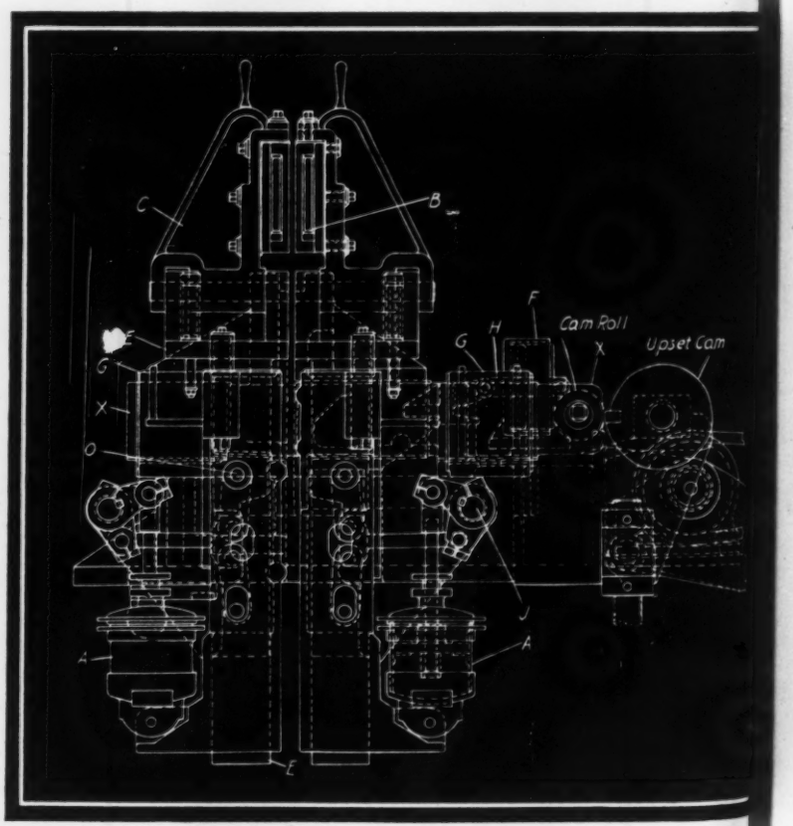


Fig. 2—Front elevation of welder showing toggle mechanism of air-operated clamps and position of upset cam

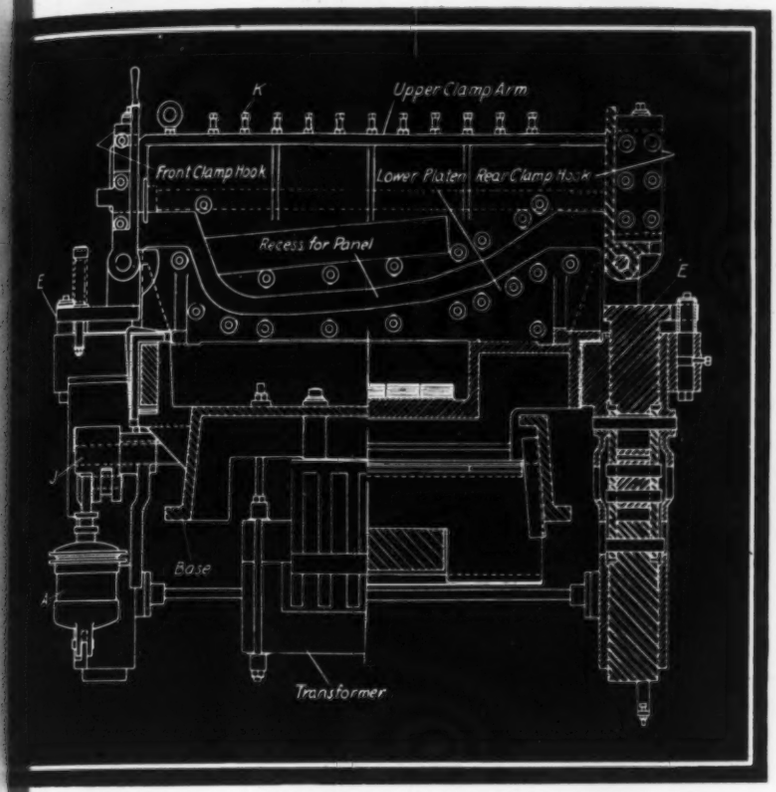


Fig. 3—Welding dies follow contour of auto body panels, clamped in recess, to charge them with high amperage current

danger of a short circuit must necessarily be obviated.

The resistance process embodies a simple idea, the origin of which goes back to forge welding. The same idea long has been employed by the blacksmith. Today the modern automobile body welder, *Fig.* 1, utilizes the fundamentals of this principle, imparting the proper amount of heat electrically to the edges of such body sections as panels, cowl pieces and peaks, and subsequently forcing them by mechanical means into a continuous structure under pressure. This type of resistance flash welding is coming into wider use as a method of joining tubular parts, rolled shapes, sheets and forgings. The intention of this article therefore is to serve a two-fold purpose, namely to acquaint the designer with the equipment used in the process and also to reveal design features of a typical machine which, in this case, is built by Federal Machine & Welder Co., Warren, O.

Air Cylinders Employed

Basically all flash welders are alike insofar as the mechanical principles are concerned. Any variations in construction depend on the type or shape of product to be welded. The machine under discussion welds together the back and side panels of an automobile body. These panels are assembled in one operation, the two seams toward the outer edges, *Fig.* 4 page 26, indicating the welds that are made in accomplishing this. It will be observed that the unit, compressing two distinctly similar sections, utilizes air for operation of its clamping cylinders which hold the body sections in position during the welding process. Hydraulic cylinders may be employed as an alternative to air; however, this variation is significant only from the standpoint of service conditions. The type of pressure that conforms best to shop facilities determines whether the unit will be equipped for air or hydraulic clamping.

First step in the welding procedure is the positioning of the right and left side panels as well as the back panel in the machine. It is necessary that the contour of the welding dies, *Fig.* 3, follows precisely that of the panels in order to make clamping absolutely effective. Because of occasional need for adjustment, set screws *K, Figs.* 3 and 5, are provided. By turning these up or down the operator of the machine can adjust the upper die so that perfect contact is effected along the entire contour of the panels. Steel pins obviate the necessity of employing extended adjusting screws.

Due to the dies being aluminum bronze it was not logical, in view of the nature of this material, to screw the holding bolts directly into them. Therefore the construction shown in *Fig.* 5 was developed. To forego the necessity of tapping, bolts with steel nuts countersunk in the face of the die are employed.

Materials Play Important Role

Aluminum bronze was selected for the dies because of its electrical conductivity and because it is sufficiently hard to provide long life. These dies, through which current is imparted to the body panels, are cooled by means of water pipes embodied in them. The platens shown in *Fig.* 5, which carry the dies, also are water cooled.

Upper clamp arms or die supports, *Fig.* 3, formerly were steel castings. This naturally entailed pattern costs which became an important item inasmuch as each different type of body requires different upper clamp arms. To reduce this expenditure a new design was introduced, embodying steel plate units fabricated by welding. Sub-bases also have been changed to welded construction. An additional desirable feature in each case was the saving in weight that resulted.

Platens or lower die supports, *Fig.* 3, are made

of gunmetal castings, this material having been selected because of its nonmagnetic properties and high conductance. Stationary platen, *Fig.* 5, is on the grounded side of the transformer while the movable platen, connected to the transformer through a flexible hard drawn copper lead, is carried on large side bars insulated by a ¼-inch sheet of bakelite. The side bars move on hardened and ground wear plates in bearings that are positioned 26 inches apart to keep them out of the way of flash thrown off during the welding process.

Toggle Mechanism Operates Clamps

Reverting to the operation that immediately precedes the clamping of the panels, clamp hooks are manually set into place over the machined ends of the clamping arms *B, Fig.* 2. Thereby the body sections are aligned and the machine is ready for the application of air clamping. The operator actuates a hand valve that admits air to cylinders, *A* the forward pair of which is shown only in the drawing. As the piston moves upward it exerts a powerful clamping pressure though the action of toggle links of hardened steel. Analyzing this toggle action it will be seen that a downward movement is imparted to plunger *E*, point *O* being fixed, which movement is transmitted to clamping arm *B* through the back hinge, *Fig.* 3, and front clamp hook *C, Fig.* 2 .

Air cylinders employed for clamping operate from an 80-pound pressure line. Cylinders are

Fig. 4—Typical body comprising one back and two side panels joined along vertical seams

designed with cast steel heads and the walls are seamless brass tubing. The smooth inner walls of the tubing eliminate excessive wear on piston leathers, found when cast iron cylinders were used. The use of brass also combats the corrosive action of moisture in the compressed air supply for the clamping mechanism.

In order that the upper welding die rests against the work along its entire length a heavy shaft *J, Fig.* 3, is employed to connect the actuating arms of the toggle levers. Without this equalizing bar, also shown in *Fig.* 1, the die might strike first at one end and then the other causing excessive wear. With this equalizing bar the machines will operate if only one cylinder of a pair is working.

With the component parts of the automobile body securely clamped in the dies the welding operation is ready to proceed. It should be borne in mind that the back panel is held in the stationary dies while the side panel is retained by the movable dies, *Fig.* 5. Jaws of the dies are approximately ¾-inch apart and each panel projects about ⅜ inch from the jaws. As the operator switches on the motor that drives a camshaft the flashing or heating of the metal begins. This heating is caused by the contact between the charged metal sheets effected as the two large upset cams, one of which is shown in *Fig.* 2, actuate the platen through rollers mounted on a shaft in slide *X* to carry the dies continuously forward. The shaft on which the rollers are mounted is eccentric to permit adjustment of the forward movement of the slide.

The motor and welding current are controlled by smaller individual cams on the main camshaft. These cams actuate limit switches to open and close the circuits at the proper intervals.

Flashing results from the electric arc or flame between the body pieces as they meet and set up a resistance to the flow of low voltage, high amperage current. During this period the high current volatilizes and burns a portion of the metal in each piece. The movable platen continues to move forward, maintaining the flashing for 6 to 15 seconds depending on the gage size of the body parts.

Uniform Heating Is Essential

Because electric current follows the path of least resistance, uniformity of heating ensues. As resistance increases with the application of heat, current always flows across the coolest adjoining areas of metal until the entire weld section reaches a uniform temperature. When about ½-inch of metal or approximately ¼-inch from each piece is consumed, adjoining areas have absorbed sufficient heat to bring them to welding temperature which is 100 to 200 degrees less than the melting point of steel.

Upsetting occurs when the highest point on the large cams reaches the roller. This upset is consummated by a hardened steel block set in the periphery of each cam striking the roller to force the heated metal together ⅛-inch. When it is considered that the upset is accomplished in a quarter of a second some idea of the rapidity of this operation may be obtained. The

synchronized limit switches controlled by one of the small cams previously mentioned cuts off the current in the first 25 per cent of the upset. During this procedure any residue of overheated metal is squeezed out and the properly heated areas brought into contact. The resulting weld has the characteristics of a forging, being free from porosity or oxide inclusions.

When welding is finished the valves are reversed, unclamping the body. The latches are dropped and clamping arms raised. An air cylinder *F*, *Fig.* 2, controlled by a third small cam returns the movable platen to the loading position, through link *H*.

By using a variable speed transmission between the motor and speed reducer the flashing

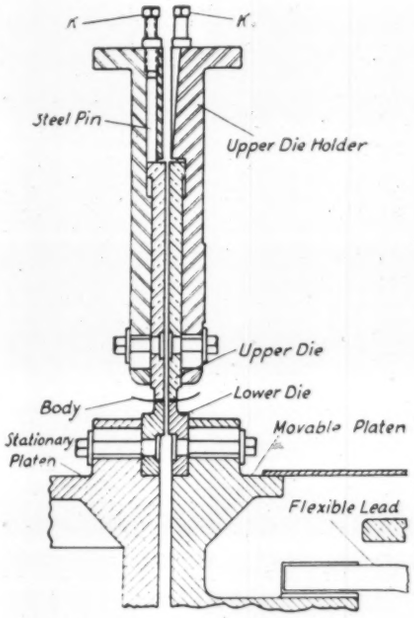


Fig. 5—Cross section through the upper portion of the machine shows the position in which the body is clamped between the dies during the welding process

interval can be controlled to meet welding requirements of any size sheet ranging from 16 to 20 gage. Transformers employed in obtaining the desired welding current are installed beneath the machine where they are entirely clear and free from flash thrown off during the welding operation. The machine requires at least 500 kilovolt amperes alternating current during the period of welding, providing of course that both sides of the machine are operating simultaneously.

Utilizes Ball and Socket Principle

Adjustment for endwise movement of the two main sections of the machine is controlled by screws operated by a ratchet lever. The front end of each unit is supported on a ball and socket joint, while the opposite end is carried by two heavy bolts arranged so that by adjusting nuts on these bolts the rear end can be tilted up to a 30-degree angle or brought down to a 15-degree angle with the base. A cross slide on the outside end of each unit is arranged so that it can be swung cross-wise of the base to compensate for weld lines not parallel with each other. This feature is incorporated to make the machine adjustable in all directions.

The development of flash welding in thin sheets has been carried up to 120 inches in length, although only in flat sheets. However, with the new car bodies, lengths in formed sheets up to 90 inches have been welded, and the only changes necessary in machines suitable for shorter welds are increased transformer capacity and clamping pressure.

Technical Invention Offers Great Possibilities

IT IS a curious fact that, as far as we know, the technical inventor is a new figure in the history of mankind," stated H. Stafford Hatfield in his paper on "The Inventor" presented as part of a symposium of papers on invention conducted by The Institution of Mechanical Engineers, London. Mr. Hatfield continued, "In every previous civilization individuals have devoted themselves to creative developments in all fields excepting technical invention. This is rather remarkable in view of the fact that the possibility of technical invention and its great economic and military value must always have been obvious. Archimedes is perhaps the only exception known to us.

"It is commonly supposed that modern technical invention is the child of scientific research, but this is certainly not the case. The experimental method of scientific research is itself an invention, which we may ascribe with justice to Galileo, and it is pursued by means of further invention, for its theories, experimental devices and instruments are all themselves inventions.

"Nothing more sharply distinguishes the genuine creative worker from those with vague aspirations to do something original than the fact that the former is prepared to take unlimited pains to acquire the necessary skill and equipment for the work in hand. A capacity for taking infinite pains does not make genius, but we rarely find genius without that capacity, at any rate in directions which serve its ends. We here touch a point at which the greatest misunderstanding exists between the inventor and the first class engineer. The latter possesses energy and industry in the highest degree, and is dominated in everything that he undertakes by a desire to see it done in the best possible manner; whereas the inventor, whose mind is concentrated on advance in some particular direction, is frequently neglectful in other matters."

Developments in External Broaching May Affect Designs

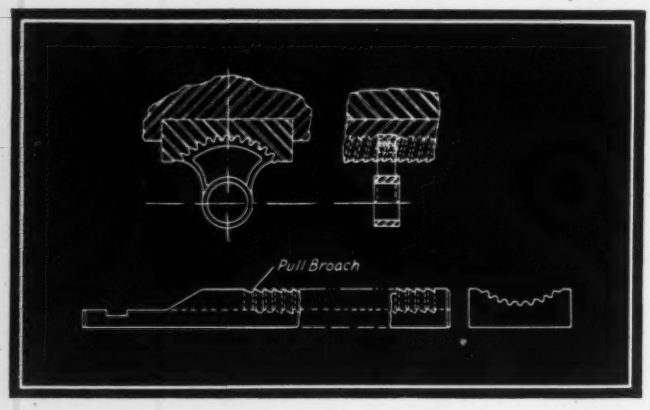


Fig. 1—Broaching gear tooth sectors from forgings

IMPROVED production processes and new applications of these processes offer a dual responsibility to the design profession. Not only will the greater employment of these processes necessitate increased activity and greater ingenuity in the design of machines to perform the production operations, but this activity will also open up new methods possibly of employment by designers in other industries who by adapting the parts of their machines to production by the new units may improve these machines and approach design perfection; lowest production cost compatible with highest machine efficiency.

At the annual meeting of the Society of Automotive Engineers, held at Detroit, Jan. 22-25, an important paper dealt with just such a broadening in the application of a production process by the automotive industry, a group that has always been a leader in such developments. Included in the paper by Joseph Geschelin, engineering editor, *Automotive Industries*, on "Potentialities of External Broaching Visioned from Analysis of Current Applications," were the following observations.

Considering external broaching as a technical process which is undergoing development and refinement during a period of rapid expansion, I think it would be premature to generalize about its ultimate possibilities or its effect upon the other production processes which have been so firmly entrenched in automotive production shops. Suffice it to say that external broaching has made tremendous strides in the automotive industry and in a relatively short time has attracted attention in many quarters. On the basis of the evidence accumulated for this paper I can say that many large plants are experimenting with it and those who have had experience with it are contemplating additional applications. Perhaps the best measure of this activity may be gained from the fact that a relatively large group of machine tool builders have developed new and improved broaching equipment which will undoubtedly be on the market soon.

The work ranges from simple finish-facing operations on small parts to the finishing of accurately controlled cam contours and the broaching of accurately finished semicircles which are said to assemble into perfect bores. We also find a number of examples of roughing and finishing gear tooth profiles for sectors.

Large Flat Surfaces Finished

Perhaps the most spectacular applications are those which are being developed for finishing large flat surfaces such as the faces of cylinder blocks and the recessing of main bearing caps which, with the exception of the last operation, heretofore required large table or drum-type milling machines to meet the demand for productivity.

I have several reports describing the external

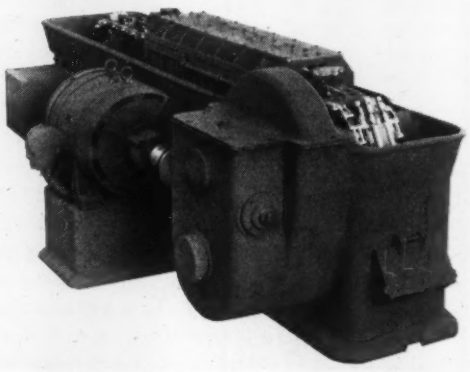


Fig. 2—Broaching machines widen production possibilities that designers may utilize

broaching of steering sectors which have been in regular production for about two years. One installation reported by the Colonial Broach Co. uses a two-spindle Oilgear broaching machine, the other is performed on a Foote-Burt Duplex machine. In each case the specifications call for a true helix curve instead of a straight tooth form. To meet this requirement the broaching operation is used for roughing only, the final finishing being done on a gear cutting machine. On the Oilgear installation the roughing cut is approximately 0.370 inch deep and production varies from 300 to 400 pieces per hour.

Segmented Cutting Tool Provided

I should like to mention in passing an outstanding development which is of interest because it touches very closely on the possibility of broaching cylindrical surfaces. I have in mind the Relay method which is to be announced by the Bullard company. While it may not be termed technically a broaching method, it does provide a segmented cutting tool so constructed as to produce a plow shearing or slicing of the metal chip and pushing it to one side so as to allow the cutting edge to advance with respect to the work. The first form of the Relay cutter was a one-piece cutter of special design for finishing bores. However, the principle may be applied to external cutting.

In general, apart from the construction features and particular advantages of various broaching machines being offered for the purpose, the most important problem concerns the design of the broach and work-holding fixtures. While both push and pull type of broaches are being used, I understand that in external broaching either construction may be used satisfactorily since the broaches are held in substantial carrier bars which are perfectly guided in the fixtures. It is unnecessary to emphasize the need for great rigidity and accurate alignment both of the broach and the work. However, this does not complicate the broaching problem in any way since these elements are considered as a part of the design of the work-holding fixture. At the present stage of the game it is difficult to say much about the trend in broach design or the design of broaching machines particularly when we consider that standardization of any kind is neither practicable nor advisable at the moment.

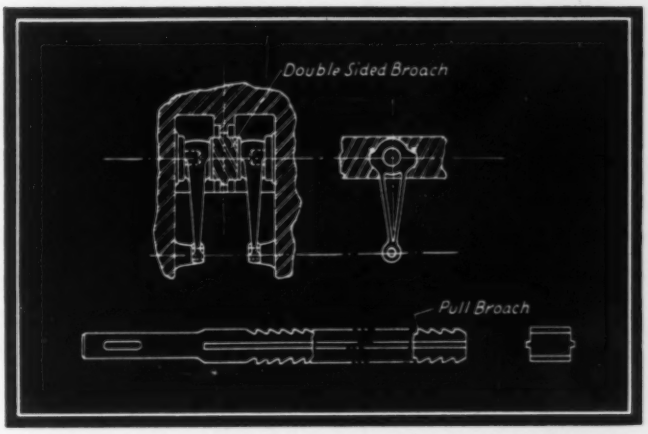


Fig. 3—Facing a connecting rod at one pass

As an index of the ability of the external broaching process to remove stock and control finished size, I have given in the accompanying table a summary of some of the available data bearing on these points.

It is safe to say that the art of external or surface broaching has provided production men with an entirely new method of finishing various types of external surfaces of large or small areas. How seriously this method will encroach upon the present methods of performing similar operations is something which must be answered by the future experience with this method as well as the competition of possible refinements in existing methods.

Under existing conditions no manufacturing concern can afford to overlook any method that promises definite advantages in the direction of lower cost or increased productivity or any of the other factors which figure so prominently in production. That this is recognized by all progressive elements in our industry is evident from the present activity and widening scope of applications of external broaching.

Data on Ability of External Broaching Process to Remove Stock and Control Finished Size

Description	Material	Operation	Stock Removed	Tolerance on Finish	Surface Speed Cutting (f.p.m.)
Crankshaft bearing cap	cast iron	finish joint face and ends to size	0.621 cu. in.		24
Crankshaft bearing cap no. 4	cast iron	step for gasket	0.221 cu. in.		18
Connecting rod	forging	faces large end	0.087 cu. in., two caps		22
Cylinder block	cyl. cast iron	4 bearing cap surfaces	1.710 cu. in.		25
Shock absorber wings	molybd. steel	broach radii	0.600 on side	0.0005 in.	
Connecting rod	forging	bolt boss contours	1/32 to 1/16		
Cylinder block	cast iron	bearing pads	0.032 in.	0.0005 in.	
Clutch lever	forging	two cam surfaces	1/16		
Universal joint rings	forging	four cross holes	1/16	0.0005 in.	
Coarse steering sector	forging	roughing	0.370		
Free-wheel clutch	forging	outer contour	3/16	0.0005 in.	33
Free-wheel cam	tool steel	four tongues	0.20	Commercial	20
Connecting rod	forging	big end radius and faces	1/8		27
Steering sector	forging	roughing 5 D. P. teeth	0.410	0.001 to 0.0005 in.	33

Varying Speeds by Motors—Controls

By Allen F. Clark
Associate Editor, Machine Design

ELECTRIC motors and controls have been adapted to solve practically all of the operating difficulties arising in the design of machinery. The ingenuity of the designers of these parts, and their experience in solving intricate control problems is almost unlimited. Naturally the exact control of the speed of a driven machine has not escaped the attention of the engineers in this group. Together with mechanical variable speed transmissions (M. D. Dec.) and hydraulic transmissions (M. D. Jan.), motors and their controls provide a wide range of units possible of selection by the designer facing a speed control problem.

In general, nonconstant speed motors may be classified into four groups: Adjustable, varying, adjustable-varying and multi-speed. Adjustable speed motors may be considered those which when once adjusted for the desired speed have good speed regulation under broad load fluctuations. Examples are the shunt wound, direct current motor; the compound wound, direct current motor with only a small percentage of series field ampere turns; the brush shifting, alternating current motor and the alternating current motor operated on variable or multiple frequencies; and the direct current motor under generator voltage control. Alternating current motors with Scherbius or Kraemer systems of control are other examples.

Adjustable-varying speed motors allow of speed adjustments but have wide speed regulation under varying load conditions, the speed increasing with decrease in load. The wound rotor induction motor when operated with resistance in the rotor or secondary circuit comes under this classification. However, the speed cannot exceed synchronism on a complete removal of the load on account of the revolving synchronous field and the inherent tendency of the rotor to slip a few per cent.

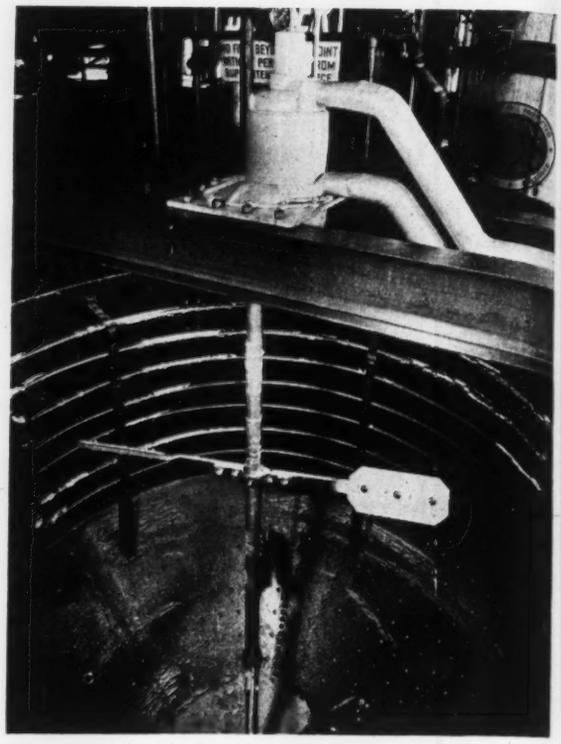
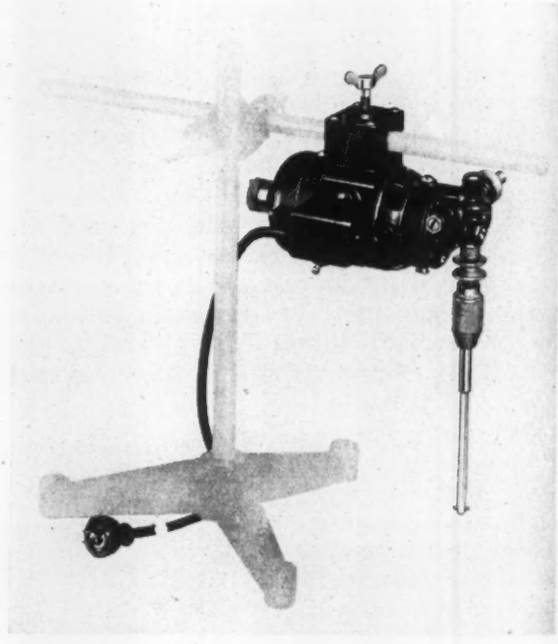


Fig. 1—Slip ring motor is used in variable speed agitator drive

Fig. 2—Governor maintains speed of motor used in air conditioning



Varying speed motors have a wide speed range varying inversely with the load, a desirable feature for some applications since it tends to prevent overload, works rapidly on low loads and slowly on heavy loads. In this class are the series wound, direct current motor and certain types of brush shifting, direct current motors.

The varying speed, direct current motor

and the brush shifting alternating current motors single and poly-phase with modified series characteristics are three popular drives where varying speed characteristics are desired. The speed varies with the load and at no load attains an upper limit above synchronism with alternating current motors; the modified series design permits them to be used with belted connections. However, belted drives are not advisable for series direct current motors since the speed reaches excessive values at no load. The inherent tendency of the motor to slow down on increase in load reduces the possibility of overload especially at the higher speeds.

Speed of a direct current series motor is usually controlled by varying a resistance paralleling the series field, a decrease in resistance increasing the speed. Numerous types of starting resistors, field resistors and drum switches in various systems of manual, semiautomatic, automatic or remote control are used for starting direct current series motors.

The brush shifting polyphase alternating current motor is usually started by some kind of a semiautomatic controller through a suitable current limiting relay and undervoltage protective device; shifting the brushes adjusts the speed at the desired values.

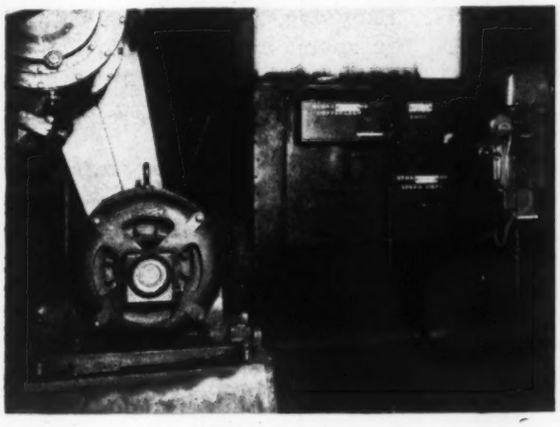
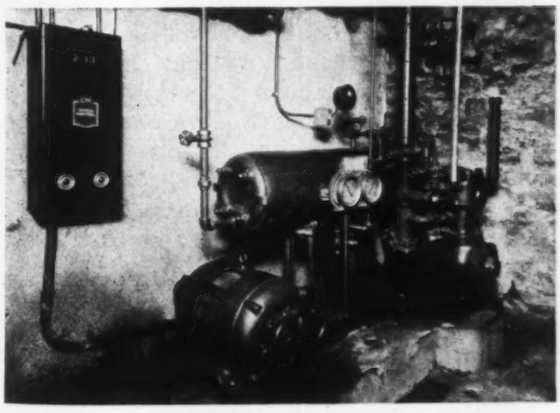


Fig. 3—Constant average speed is provided by integrating controls

Fig. 4—Two distinct windings are employed on compressor motor



Control for the single phase, brush shifting motor ordinarily consists of magnetic starting switch, push button station and brush shifting mechanism. On account of the comparatively small ratings the motor may be thrown across the line. Shifting of brushes changes speed.

A geared, direct connected, slip ring motor, with ventilating attachments, speed indicator, gas tight protection and slip ring compartments, is used to obtain variable speed on the agitator drive shown in *Fig.* 1. Speeds from 95 to 13 revolutions per minute are provided.

Multispeed motors have 2, 3 or 4 widely separate fixed speeds and may be operated at any one of these speed by the use of selective control; in some instances a variation from the fixed speeds can be arranged. The squirrel cage, induction, 2, 3 or 4-speed motor, the synchronous motor with two speeds; the wound rotor, induction motor with two speeds, each adjustable-varying, and the induction two-frequency motor are the results of designs to secure multiple speed.

Electric governors, incorporated as an integral part of the motor, provide an efficient means of obtaining variable speed electrically. The new laboratory stirrer motor, *Fig.* 2, employs essentially a universal series wound motor which gives it the characteristic of such motors, high horsepower per pound, and includes also an electric governor of a sensitive type which may have its speed setting adjusted while the motor is running. The speed range covered by the governor is from zero to 8000 revolutions per minute on the armature shaft.

Resistance Mounted Internally

The unit is also combined with a gear reducer of a double reduction type, with a slow speed shaft coming out of each reduction. A small box mounted on the motor frame contains the condenser used across the contacts of the governor. The resistance units in series with the motor are connected across the governor contacts and parallel with the condenser. They are mounted internally in the motor. Considerable air is drawn in by the governor which acts as a fan, the air passing through and around the motor laminated structure, made possible by the use of a ribbed housing with ventilating ducts between portions of the frame and the laminated field yoke.

Stokers and conveyors form a group of machines in which speed control is absolutely essential. Types of motors which have been found applicable for such equipment include adjustable speed direct current motors, wound rotor type alternating current motors and brush shifting type adjustable speed alternating current motors.

As a further step in the development of motors for this service and in order to maintain a con-

stant average speed there has been developed an adjustable delivery drive for alternating current. This drive, suitable for those applications in which a change of speed within a given interval is immaterial provided a certain average constant speed for that interval is maintained, utilizes a multi-speed motor together with a control unit, either automatically or manually operated.

The multispeed machine with two or three speeds which is part of this drive is essentially a simple rugged squirrel cage motor without commutator, slip rings, brushes or other live parts. *Fig.* 3 shows this motor together with the control units consisting of a drum selector switch, a transfer contactor panel and a main line contactor.

Selector Switch Employed

Speed is controlled by the selector switch, diagrammatically shown in *Fig.* 5. The selector drum consists of a copper cylinder divided into sections insulated by air gaps. This drum is rotated by a pilot motor and has bearing upon it stationary brushes fixed in position, there being one such brush for each one of the windings of the multispeed motor. There is, in addition,

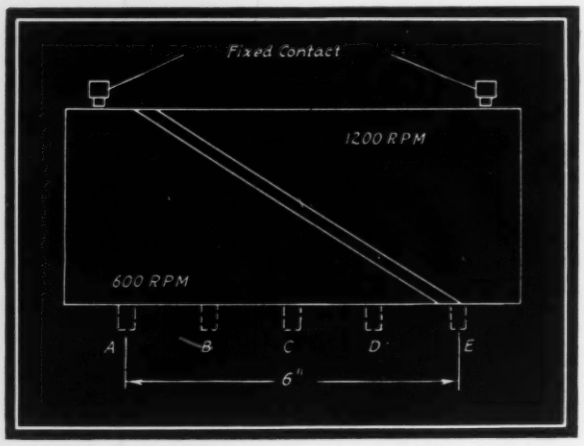


Fig. 5—*Selector switch governs percentage of time each speed is used*

one adjustable brush, mounted on a slide which permits movement along the total length of the drum. This brush is positioned as desired on the cylinder by means of a steel cable passing over two pulleys, the shaft of one pulley extending to a handle located on the outside of the cabinet.

To make the operation of the unit perfectly clear, the following explanation is made of a multi-speed motor of 600 and 1200 revolutions per minute, selected because of its simplicity. This motor has two separate windings and will run at 600 or 1200 depending on which winding is selected. For further simplicity, a two-speed control drum is used. Reference is made to *Fig.* 5.

It will be assumed that the split section of the drum covers 6 inches of the length of the drum. At *A* the motor runs at the minimum speed of 600 RPM at all times. With the adjustable brush moved to the position shown at *B*, 1½ inches from *A*, the motor will run for ¾ of a minute on the 600 RPM winding and for ¼ of a minute on the 1200 RPM winding, giving an average speed of 750 RPM. Similarly, with the brush moved to *C* the average speed will be 900 RPM while at *D* the average speed will be 1050 RPM. At position *E* the adjustable brush is in contact only with the right-hand segment of the drum and the motor will run at 1200 RPM at all times. It is evident that between 600 and 1200 RPM there is an infinite number of average speeds possible.

By replacing the handwheel of the adjustable brush with a small sheave pulley or sprocket, the average speed may be controlled automatically from a suitable source. For example, on a stoker the familiar scheme of diaphragm control by means of steam pressure may be applied so that in the event of the pressure increasing or decreasing to a predetermined point, the speed of the drive will be changed automatically in order to establish the proper delivery of fuel.

The vast majority of applications in which motors or controls are employed to give varying speeds are not in a true sense variable speed applications. They are, rather adjustable applications with the speed adjustable to a number of different definite values as contrasted with values varying by an infinite degree.

Accommodates Varying Loads

Multispeed motors are widely used to provide characteristics of this sort. The motor shown in *Fig.* 4, used to drive a refrigeration compressor unit on which the load will vary widely, is of the constant torque high starting torque, low starting current type. The motor field is supplied with two separate and distinct field windings so that the two speeds at which the motor may operate are entirely independent of one another. Consequently, the manufacturer of the compressor was able to select two speed combinations which best suited the peculiar conditions. Automatic selection of the speed of the motor being controlled is obtained by a mercoid suction pressure switch. So long as the suction pressure is above 35 pounds per square inch the motor will operate on high speed, but if the suction pressure goes below 35 pounds the motor will operate on low speed.

The application of speed control by electrical means to fractional horsepower motors has been infrequent, yet in an air conditioning unit designed for residential use it was necessary to regulate the amount of air drawn into the room and circulate it without causing a draft. The unit consists of an air filter and a motor driven

fan, a small rheostat being used to control the speed of the fan motor. The unit employed is shown in *Fig.* 6 and is known as a Vitrohm Adjustat. To make the rheostat operative from the front of the enclosure panel the shaft was insulated from the contact lever, thus avoiding the use of insulating bushings. It is provided with 16 steps of control and will dissipate 30 watts continuously with a temperature rise not exceeding 250 degrees Cent., which is within the limits specified by the Underwriters' Laboratories.

Electrical control devices include multi-speed squirrel cage motor controllers of the drum or magnetic type, available in 2, 3 or 4 speeds; nonreversing, one speed reverse or full reverse; consequent pole (two speed from one winding) or separate winding type; constant torque (dough or pulp mixers, reciprocating pumps, etc.); constant horespower (lathes, drill presses and other machine tool drives). No external resistance, reactance or transformer is required to obtain the different speeds as the speeds are provided by windings forming different numbers of poles. Speeds are practically constant regardless of load (less the inherent slip speed characteristic of squirrel cage motor design).

Employs Magnetic Contactors

Automatic multi-speed across-the-line starters consist of a single 3, 4, 5 or 6-pole magnetic contactor for each speed; the number of poles depending on the type of motor windings and the number of speeds. The contactors for each speed are mechanically and electrically interlocked so that if an operator should push another speed button while the motor is running, no harm to man, motor or machine will occur. An inherent feature of this type of control is low voltage protection (three-wire control) or low voltage release (two-wire control), depending on the type of pilot circuit control accessory used.

Faceplate controls for speed regulation of slip ring motors are available up to 25 horespower with the drum type recommended for higher ratings. Also it is considered better engineering practice to use drum type apparatus in the lower ratings where frequent operation of the controller will be experienced. Most fans, blowers and pumps and certain types of machinery drives are a few applications where faceplate regulators are ideally suitable. Ten or more steps of speed regulation are provided in the standard design with a maximum of approximately 50 per cent speed reduction.

Speed regulation is obtained by shorting out different values of the external rotor resistance furnished as an integral unit of the face plate regulator. As the face plate regulator only handles the secondary circuit of the slip ring motor, it is necessary that a separate switch be provided for handling the primary circuit and it is recommended by the manufacturers that a magnetic switch providing low voltage and overload protection be used.

Treadle operated controllers are used for small direct current or universal type motors up to ½ horsepower. They provide stepless speed control by the use of a gaphite compression resistor. A speed reduction of approximately 50 per cent is obtainable with the standard regulator. When the treadle is in the off position, an internally mounted switch opens the line circuit. The regulators have been used extensively for controlling sewing machines, small lathes, winding machines, saws, drills, etc.

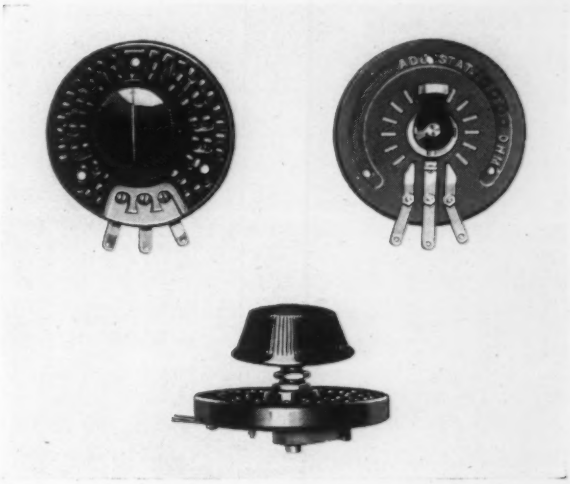


Fig. 6—Rheostat provides sixteen steps of control over its range

Reversing Types Available

Alternating current slip ring drum controllers are available in both reversing and nonreversing types. The nonreversing type drums regulate the secondary current of a slip ring motor through resistors and thus control the motor speed. Fifty per cent speed reduction is furnished as standard and the drums usually have 10 or more steps. The reversing type drum controls differ from the nonreversing type in that a set of reversing motor primary circuit contacts are provided in addition to the speed regulating secondary circuits. The drums usually are interlocked with a magnetic primary switch in such a manner that all arcing is taken on the magnetic primary switch.

For their considerate assistance in the preparation of this article and for the illustrations included, MACHINE DESIGN wishes to thank the following manufacturers of motors and of electrical controls: Allen-Bradley Co.; Allis, Louis, Co.; Bodine Electric Co.; Century Electric Co.; General Electric Co.; Sterling Electric Motors Inc.; and Ward Leonard Electric Co.

MACHINE DESIGN

L. E. JERMY, EDITOR
ALLEN F. CLARK
HAROLD B. VEITH
F. H. BURGESS

Survey of Operating Conditions Is Essential During Design

INVESTIGATION among users of machinery in certain fields reveals that there still is a lack of understanding by designers of the actual conditions under which their machines operate. With reduced incomes there is a limit to traveling and visits to customers and potential customers that machinery manufacturers can finance; yet it often is less costly to make an investigation of operating conditions and to design a machine to meet them, than it is to pay the expenses of a service department in remedying imaginary or actual grievances on the part of the user after the machine is installed. Loss of good will and confidence in the machine also are considerations.

A pertinent example was brought to light recently in the bakery field. Two different types of machines failed to measure up to the expectations of the buyer. Mechanically each machine was sound, but due to the designers not having sufficient knowledge of the characteristics of the materials to be processed by the machines when developing them each unit gave trouble. Much or all of this could have been forestalled.

If business conditions continue to improve there will be a demand for designers in the near future. The engineering department executive engaging new men unquestionably would be well advised to select those capable not only of turning out good mechanical design but also qualified to go into the field, contact customers, observe operating conditions, and apply the knowledge thus gained to the betterment of his work.

• • •

Give and Take!

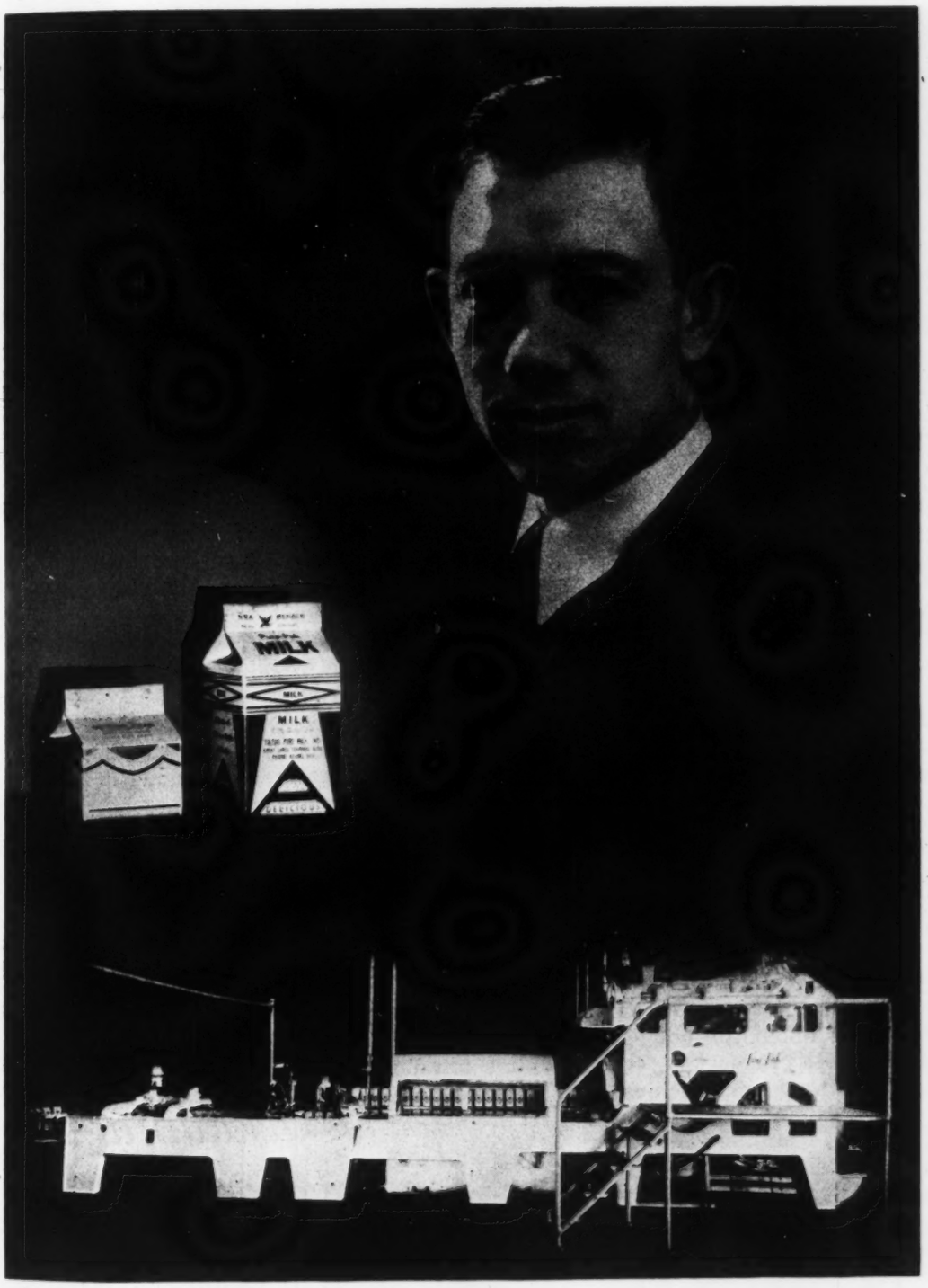
IN A CODE of ethics for engineers adopted by the A.S.M.E. at its annual meeting in December many noteworthy clauses are incorporated. One in particular stands out: ". . . . it is the duty of every engineer to co-operate in building up the engineering profession by the interchange of general information and experience with his fellow engineers, and also by contributions to the work of engineering societies, schools of applied science and the technical press."

MACHINE DESIGN has found among its readers a distinct willingness whenever practicable to disclose their findings in organization, research, development and design work. There are some, however, who through inertia or otherwise prefer to read about what "the other fellow" is doing rather than contribute their own quota. Transference of knowledge should be reciprocal and it is fortunate for progress that most engineers appreciate the desirability of considering the subject in exactly that light.

MEN

and Their

MACHINES



HENRY T. SCOTT AND HIS PAPER BOTTLE FILLING MACHINE

Men and their Machines

Packaging Machinery

FARSIGHTED vision is one of the most valuable assets of an engineer. Possession of this characteristic in an impressive form accounts for the success of Henry T. Scott. Because of his ability to sense the future trend toward increased use of packaging machinery, his name now is closely identified with a new machine and method of packaging liquids in cellulose containers. As chief engineer of the American Paper Bottle Co., Toledo, O., he is in responsible charge of machine design and manufacture.

Early boyhood experiences bore every indication that he would grow up to be an engineer. Born in Toledo on May 22, 1900, he moved with his parents when six to a farm near Oakwood, O., and like all boys brought up in this environment soon became familiar with mechanical implements employed in agriculture. Of particular interest among the apparatus available to him, however, was a domestic lighting plant that added tremendously to his mechanical and electrical training. It enabled him to "experiment" and permitted his creative bent to assert itself. Next came high school. At 14 he graduated and spent the following two years in shipyards at Detroit and Buffalo. Then he gained carpentry experience in Northern Michigan.

War service followed, Mr. Scott enlisting in the Army Air corps in 1918. His promotion to first class sergeant came in several months; he was chief inspector and chief motor mechanic of the ninety-sixth aero squadron. Later as a flying cadet, he instructed numerous classes in motors, rigging, electricity, instruments and flying. Having reached the rank of second lieutenant in 1922 he resigned because of his father's illness.

Home again, he took a position as draftsman at Champion Spark Plug Co. Employment by the Dura Co. and Toledo Scale Co. added to his knowledge. In 1925 he became a special machine designer with Toledo General Mfg. Co., and soon was appointed chief engineer. His association with the organization terminated in 1931. By this time he already had started consulting design and development work on the paper bottle and equipment for his present organization. In 1931 he joined the company, organized the engineering department and took charge of all manufacturing operations.

Mr. Scott might be accused of being a dreamer, although not one of the proverbial type. At any rate he talks in his sleep (according to his wife!) about the bottle machine. That is not a fault; it proves the fertility of his mind. Consciously and subconsciously he pursues design ideas, sometimes staying up all night to record them.

PROFESSIONAL VIEWPOINTS

Machine Design Welcomes Letters Suitable for Publication

Slide Valves Will Not Foul

To the Editor:

MANY machines require connection to the common works service mains for water, compressed air, steam, fuel oil, etc. Such machines are liable to suffer, particularly when first installed, from pipe scale, rust, die chips, too copiously applied pipe dope and debris in general. As it seems that no amount of reform work will suffiiciently impress the necessity of cleanliness, and such precautions as blowing out lines before connection, upon the mechanical force, it might be advisable for the designer to look about to see what has been done in similar lines of work to counteract the same evils.

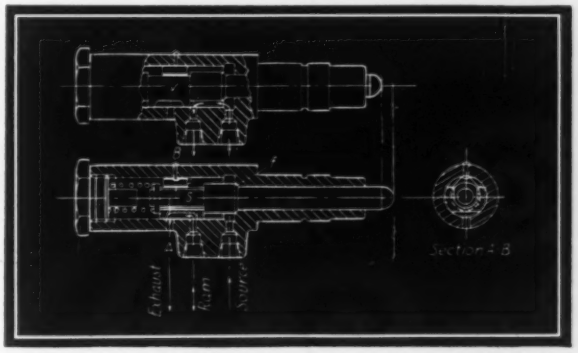
A pneumatic system for operating a series of rams offers a good example of the problem. The original inlet and exhaust valves were poppets and in spite of all ordinary precautions grit would unseat the valves and cause accidental functioning or misfunction.

Strainers were fitted but were not satisfactory. The finest perforated metal screens were too coarse, practical punch size being the limiting factor. The weft and warp of wire cloths crowd leaving spaces of far greater size than the normal mesh. Neither type of strainer will stand any considerable differential of pressure due to clogging. Felt is easily clogged and may be removed entirely by the operator.

An examination of several air brake devices altogether unrelated to the machine being developed showed what was lacking in design knowledge in this case. These air brake valves as far as possible were of the sliding type. Slide valves do not leave their seats to admit grit. They simply push it along to be blown through.

Re-design resulted in the control valve shown in the accompanying illustration which has been used since in a number of manual and cam-controlled operations. A little D-slide valve *v* works in a reamed hole in the housing. The cylindrical form tends to small size and cheapness of production. The valve is unbalanced slightly by cutting away part of it opposite the ports. This allows easy assembly over the stem *s* as well as tight seating. A flat spring holds the valve from turning and keeps it on its seat when the air pressure is off.

When the air pressure is on it tends to eject the valve stem until it seats at *f* preventing leakage along the stem and holding the valve in the exhaust position. Thus if air is turned on at some point not under control of the machine operator the valve simply moves over, shutting the air off the ram and opening the exhaust. In this position any leakage of the slide valve is exhausted preventing creeping of the ram when it is supposed to be shut off.



Redesign prevents leakage and accidental functioning of valves for pneumatic system

Made of nonrusting materials this adoption from a totally foreign field has been thoroughly satisfactory.

—HAROLD F. SHEPHERD,
Annapolis, Md.

Doubling the Crank Stroke

To the Editor:

REDESIGNING machines already built frequently offers ample opportunity for exercising the ingenuity of the designer. For example, a slight change in the heat treating specifications of the product in one plant required that a combination hardening and quenching machine be remodeled. This machine was used for heat treating tractor axles and the redesign called for an increase in the movement and velocity of the axles in the quenching bath, equal to the original movement and velocity. The original movement was imparted by an ordi-

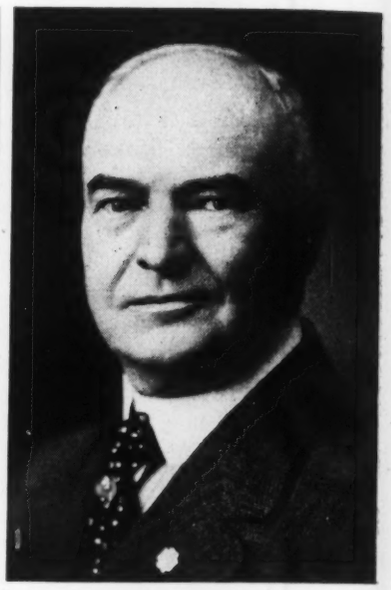
(*Concluded on Page* 61)

MEN OF MACHINES

IN RECOGNITION of outstanding service in the field of engineering as related to agriculture, the American Society of Agricultural Engineers recently elected William N. Rumely an honorary member. A pioneer in the farm machinery industry, his engineering activity has been chiefly in the development of threshing machines, steam traction engines, clover hullers, etc. Mr. Rumely was one of the technical men who during the eighties and nineties pioneered the application of mechanical power to farming operations.

LaPorte, Indiana, was his birthplace and March 2, 1858, the date. His early education was directed toward a mechanical career and from 1878 to 1879 he took special work in machine design at Stevens Institute. Returning to engage actively in his father's business at LaPorte, he was in 1881 appointed superintendent and engineer. During the next six years his achievements included designs of outstanding mechanical farm equipment. Twenty-seven patents were granted to him over a period of 30 years.

In 1886 he was made vice president of the company. The presidency was accorded him in 1904, the organization then having become known as the M. Rumely Co. Mr. Rumely has held a number of executive positions, among which is his present post as head of the Stocker-Rumely-Wachs Co.



WILLIAM N. RUMELY

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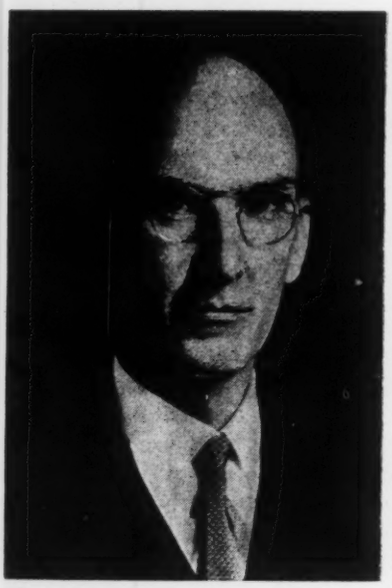

JOSEPH A. JOHNSON

PROMINENT role has been played in the field of power generation and transmission by Joseph A. Johnson, newly nominated president of the American Institute of Electrical Engineers. Perhaps his most important achievement in this direction was the development of a system of generator voltage control by individual regulators. Today he is chief electrical engineer of Buffalo, Niagara & Eastern Power Corp., Buffalo.

Mr. Johnson was born at Northboro, Mass., June 21, 1882. In 1905 he was graduated from Worcester Polytechnic institute with the degree of bachelor of science in electrical engineering. From 1905 to 1912 he was affiliated with Ontario Power Co. of Niagara Falls. As electrical engineer with the Niagara Power Co. he was responsible for many important features of the design of Niagara developments during the period of their rapid growth from 1918 to 1924. Mr. Johnson was appointed to his present position in 1929.

In addition to his numerous Institute activities (he became a fellow in the A.I.E.E. in 1927.) Mr. Johnson served the former National Electric Light association as chairman of its electrical apparatus committee, as a member of its power systems engineering committee, and is at present chairman of the electrical equipment committee of the Edison Electric institute.

STANDARDIZATION work is one of the chief technical interests of F. M. Farmer. It is noteworthy therefore that he recently was elected vice chairman of the Standards council of the American Standards association, representing the American Society for Testing Materials. Since graduation from Cornell university in 1899 with a degree in mechanical engineering he has been identified principally with the electrical field. After a year with General Electric Co. and two and one-half years at New York navy yard, he joined in 1903 the staff of Electrical Testing Laboratories. He now is vice president and chief engineer of that organization.

Because he has been extremely active in industrial research, testing and inspection of electrical engineering materials and apparatus, Mr. Farmer is widely known in his profession. Welding is another field to which he has devoted much time, dating back to his association with research work of the welding committee of the Emergency Fleet Corp. in World war days.

American Society for Testing Materials and American Welding society are technical organizations of which he is past president. Other groups with which he is affiliated include: American Institute of Electrical Engineers, American Society of Mechanical Engineers, and the engineering division of the American Research council.

F. M. FARMER

• • •

F. J. BOMMER JR.

WORD emanates from the Potter Refrigeration Corp., Buffalo, that Ferdinand J. Bommer Jr. has been appointed chief engineer. The selection brings to the forefront in the organization a man whose experience in refrigeration has been unusually broad. It ranges from household refrigeration to the planning and supervising of installations in some of the best known hotels throughout the United States.

Born in Buffalo in 1896, Mr. Bommer was graduated from Central High School in 1914. His early commercial training was gained through his connection with his father's business and in building contracting. Subsequently he became affiliated with the Jewett Refrigerator Co., Buffalo, being engaged in various capacities over a period of 14 years. During his last six years with the organization he was chief engineer.

It is interesting to note that the company with which Mr. Bommer is engaged recently issued a study showing the relation between refrigeration and public health. This significant paragraph is typical of the report: "Is this a coincidence or not? Before refrigeration was widely used the peak of mortality was in the summer. As refrigeration became widely used the peak of mortality shifted from summer to winter."

• • •

L. F. HICKERNELL, formerly electrical engineer in charge of the cable engineering department and Hastings laboratory, Anaconda Wire & Cable Co., Hastings-on-Hudson, N. Y., has been appointed chief engineer of the organization.

* * *

AUGUST DUESENBERG, brother of the late FRED DUESENBERG, recently was made chief engineer of Duesenberg Inc., Indianapolis.

* * *

HARRY HARRISON, Carrier Engineering Corp., was made first vice president of the American Society of Refrigerating Engineers at the recent annual winter meeting in New York. Second

vice president is Sam Bloom, Chicago consulting engineer.

* * *

G. M. FOULKROD, formerly associated with the agricultural engineering staff at Pennsylvania State college, has joined the new agricultural engineering department that has been organized at the University of New Hampshire, headed by W. T. ACKERMAN.

* * *

FRANK J. SPRAGUE was honored by the unveiling of a plaque of himself at the recent meeting of the American Institute of Electrical Engineers to which it was presented. His inventions have earned him the title of "father of modern rapid transit."

* * *

RAY PATTEN has been engaged to advise and assist the engineering and sales departments of the General Electric merchandise department in the styling of household appliances, home laundry equipment, radios, vacuum cleaners, etc.

* * *

LEO W. GROTHAUS, Allis Chalmers Mfg. Co., Milwaukee, and Robert M. Gaylord, president, Ingersoll Milling Machine Co., Rockford, Ill., have been elected to the executive committee of the Machinery and Allied Products institute.

* * *

C. HAROLD WILLS, one-time president of Wills-St. Clair, and FRED SLACK, formerly chief engineer of Peerless Motor Car Co., have become members of the engineering staff of Chrysler Corp.

* * *

GLENN W. MCCUEN, professor of agricultural engineering, Ohio State university, Columbus, O., has been nominated president, and ALBERT W. LAVERS, chief engineer, tractor division, Minneapolis-Moline Power Implement Co., is nominee for first vice president of the American Society of Agricultural Engineers.

* * *

A. H. FEDDEN, Bristol Aeroplane Co. Ltd., England, recently received the Manly Memorial medal awarded annually to the author of the best paper relating to theory or practice in the design or construction of, or research on, aeronautic power plants or their parts or accessories. The Wright Brothers medal was presented to E. N. JACOBS of the National Advisory Committee for Aeronautics, Washington. This award also is made annually to the author of the best paper on aerodynamics or structural theory or research, or airplane design or construction. The honors were conferred at recent annual meeting of the Society of Automotive Engineers in Detroit.

* * *

CARL SIEWEKE has joined the staff of the Campbell-Hausfeld Co., Harrison, O., where he will be identified with engineering and production work.

* * *

FREDERICK M. FEIKER recently was appointed executive secretary of the American Engineering council. For the past 13 years the position has been held by LAWRENCE W. WALLACE who resigned to become vice president of the W. S. Lee Engineering Corp.

* * *

O. S. MCGUFFEY has been appointed chief engineer of Kold-Hold Mfg. Co., Lansing, Mich. He has been with the company since 1932, previously having worked on truck refrigeration with Kelvinator.

Obituary

GIUSEPPE FACCIOLI, former works manager and associate manager of the Pittsfield, Mass., works of the General Electric Co., died recently. Nearly four years ago he retired from active service because of ill health (M. D. July, 1930). Italian by birth, he was born in Milan in 1877, the son of an Italian colonel. Following his graduation from the University of Milan thirty years ago he came to this country. His first employer here was the New York Edison Co. and subsequently he became associated with the Interborough Rapid Transit Co. Later Mr. Faccioli accepted a position as designing engineer for Crocker Wheeler Co., and finally became connected with General Electric, in the railway department at Schenectady. Mr. Faccioli worked closely with the late Dr. Charles P. Steinmetz and like him was a cripple. Unable to walk, he was wheeled about his laboratory and office.

Leadership

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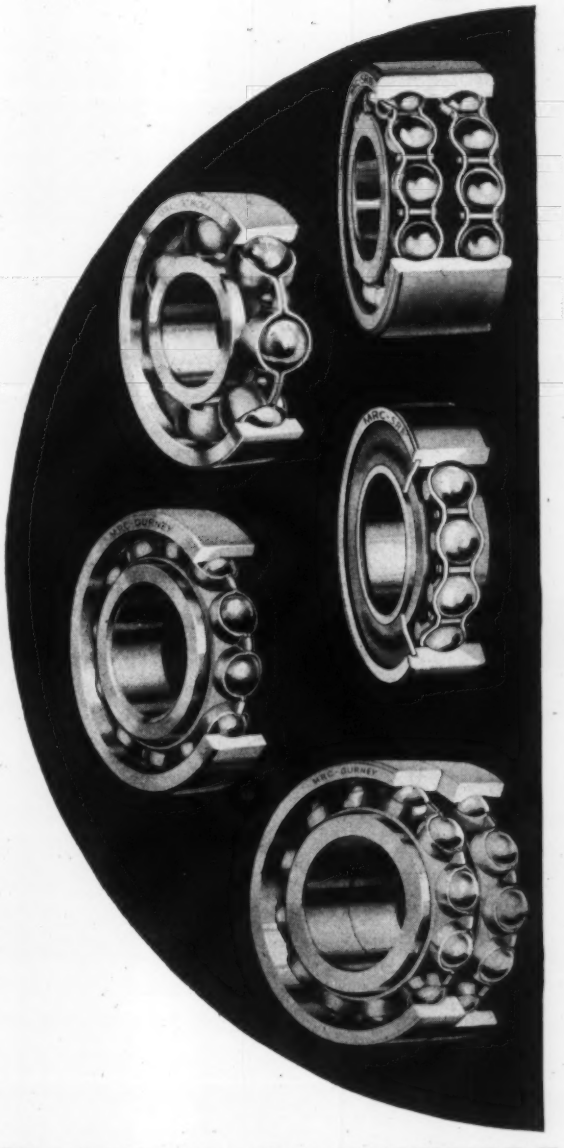

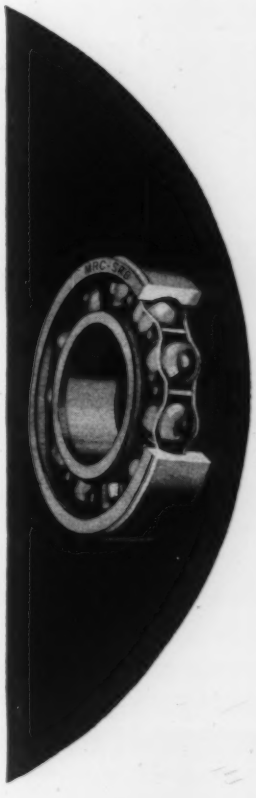

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TOPICS

Finds Industry Is Optimistic

SEVERAL startling facts were uncovered by a recent survey made by a special committee, appointment of which was authorized by the Council of the American Society of Mechanical Engineers. The capital goods industries on which mechanical engineers depend largely for employment was investigated. Findings reveal that about two-thirds of the concerns have no definite plans for modernization of machinery and mechanical equipment. Many of the companies report that they would not invest in machinery or mechanical equipment at the present time, but the majority was optimistic toward the immediate future.

* * *

Welding Commands Wide Interest

WELDING is a topic of importance throughout the world if the returns on a newly published book on the subject are to be taken as a criterion. Orders were received from 13 different foreign countries in a single day for the book, "Procedure Handbook of Arc Welding Design and Practice," introduced recently by Lincoln Electric Co., Cleveland. More than 1000 copies have been sold each month since publication. A review of the volume appeared in the October, 1933, issue of MACHINE DESIGN on page 41.

* * *

Crankless Diesel Wins Attention

NEXT to the automobile from the standpoint of popular appeal comes the power boat. It therefore was a stirring event at New York recently when the National Motor Boat show opened at Grand Central Palace. From a mechanical design viewpoint one of the outstanding features was a crankcase diesel engine built by Sterling Engine Co., Buffalo, under license from A. G. M. Michell. Compact construction, obtained in part through the absence of crankshaft, camshaft, cylinder head, etc., adapts it to streamlined boat and vehicle design. Power generated by the pistons is transferred to inclined disks, which virtually are flywheels, mounted on a straight drive shaft at each end of the engine.

* * *

Fog Camera Extends Visibility

IN THE marine field one of the interesting recent developments is the new "fog camera" designed to increase the limit of visibility of the navigator from two to four times. Initial installation was made on the MANHATTAN of the United States Lines. The new instrument records on a specially treated infra-red ray film strip fog-hidden objects ahead of the ship, develops and "fixes" the negatives in 30 seconds. The operator or navigator can view the picture by pressing a button.

* * *

Engineers Attack Noise

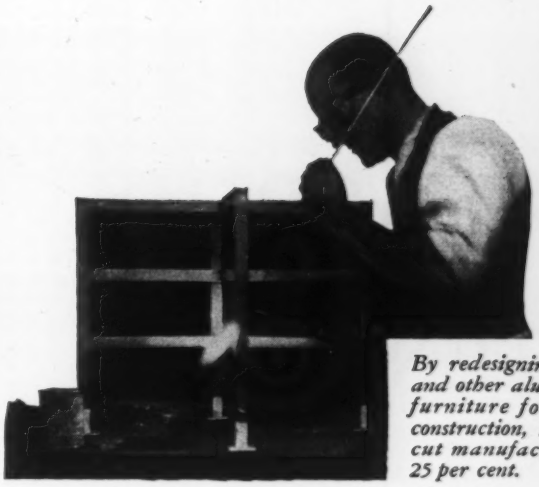
OUTSTANDING topic at the recent S.A.E. convention was noise. In an auto, T. M. Prudden says, two angles of treatment must be pursued. One is insulation and the other absorption. Both must be employed to obtain reduction of noise.

* * *

Honored for Research Activity

ENGINEERS, particularly those in the field of industrial research, join in congratulatory expression to the recipient of the gold medal offered by the American Institute of the City of New York. On Feb. 1 the General Electric Co. will be presented with this medal "for pioneering in industrial research."

Design for OXWELDING *and lower production costs*



By redesigning this table and other aluminum alloy furniture for oxwelded construction, the producer cut manufacturing costs 25 per cent.

OXY-ACETYLENE welding lowers production costs because it provides a method of fabricating metal without slow and expensive mechanical jointing . . . By making joints stronger than the metal itself, it permits the use of lighter material or the substitution of shape-cut fabricated parts for castings . . . And by making a smooth, invisible joint, it makes painting, lacquering, enameling, or polishing easier and quicker.

If in your plant otherwise good designs are being shelved because their production cost is prohibitive, or if present production methods restrict your abilities as a designer, investigate the advantages that oxwelding offers.

Write today for complete information —or, if you prefer, one of our engineers will be glad to study your product and tell you frankly, and without obligating you, where oxwelding and cutting can be used to advantage in your production.

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NOTEWORTHY PATENTS

CAMS judiciously employed by the designer offer tremendous possibilities in solving mechanical problems. A unique application is found in a seaming machine for cans. Patent No. 1, 941,972, recently was granted for this unit to William Cameron, the Cameron Can Machinery Co., Chicago, being assignee.

The double seamer, as the machine is known, employs a rotating head that carries tools or dies for seaming the peripheral edge of a can end to the outwardly flanged end of a can body. The dies are so shaped as to form a double seam, being actuated toward and from the can body by differential action between speeds of rotation of a head to which cam arms are pivoted, and a second rotary cam member.

Examining the machine, *Fig.* 1, it will be observed that the operator throws clutch lever 7 to start the unit, after placing a can and can end to be seamed on table 66. Subsequently foot lever 91 is depressed until cam roller 93 is engaged by lower portion 94 of cam arm 87. During upward movement of the table the can cover engages template 59, *Fig.* 2, which is in its lowered position.

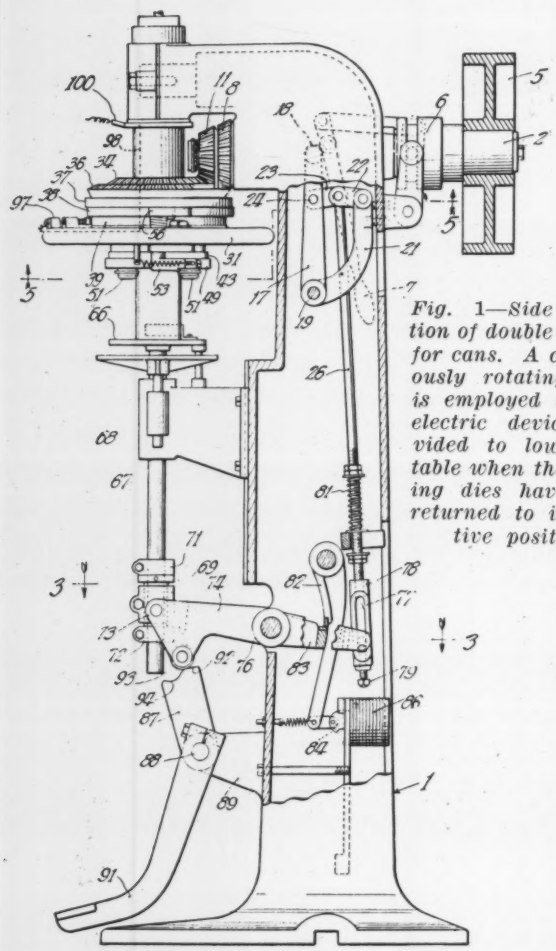


Fig. 1—Side elevation of double seamer for cans. A continuously rotating head is employed and an electric device provided to lower the table when the seaming dies have been returned to inoperative position

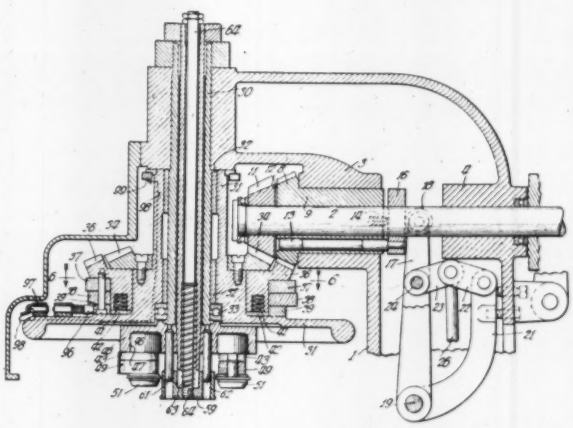
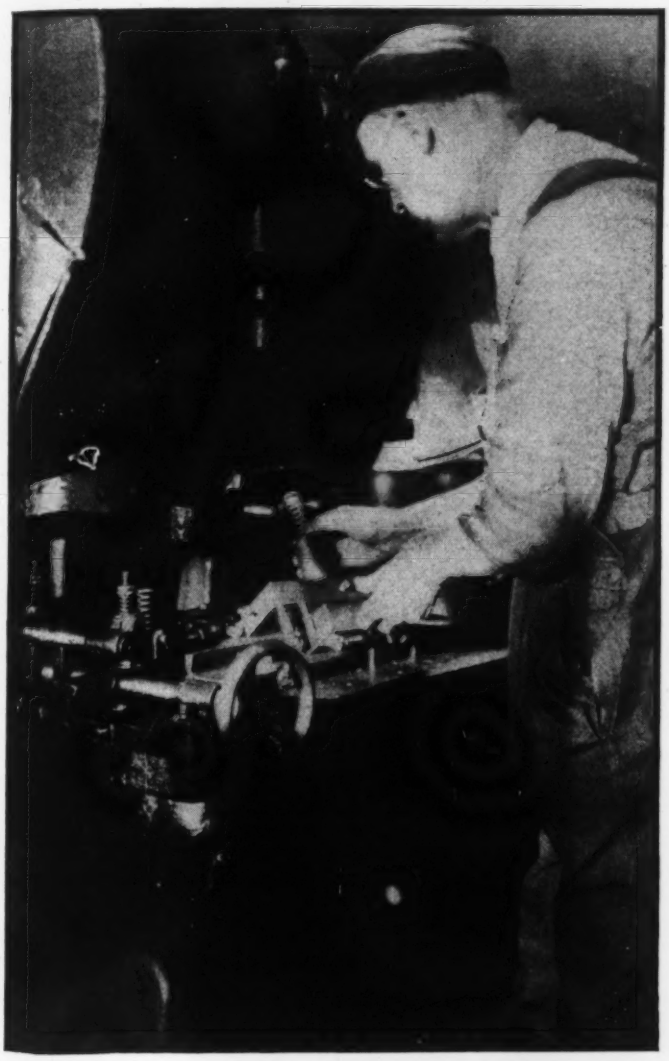


Fig. 2—Movement of the seaming dies is effected through differential action between cams and head

Foot lever 91 then is depressed to its full extent, causing roller rod 26 (*Figs.* 1 and 2) to force clutch pin 13, *Fig.* 2, into engagement with gear 11. This effects a differential action between gear 36 carrying cams 37, 38 and 39 and head 31. The head is driven frictionally by ring gear 36 through gear 8 when gear 11 is disengaged from shaft 2 by retraction of clutch finger 13.

Seaming dies 51 are actuated through a pair of lever arms 43 pivoted at one end on studs secured to head 31. Free ends of the levers project inwardly toward center of the head and carry rollers 46 which travel in cam groove 47 formed in cam plate 48. Rollers 46 move levers 43 and 49 and die 51 into proximity of to the can top and cause it to follow the contour thereof. Levers 49 with dies 51 are moved relatively to

SOLVING UNUSUAL SPRING APPLICATIONS



$$n = \frac{1}{\frac{S_o}{S_y} + \frac{S_v}{S_e}}$$

WITH springs playing a vital part in the operation of most machinery—it is essential that their design be given the utmost care and attention. This applies particularly where special or unusual conditions exist—and where new and untried service is called for. In such instances, formulae, to arrive at a working hypothesis without error, must be based not alone on stress, torsion and other set conditions of operation—but, also, on such important factors as the tensile and fatigue properties of the material used. The thorough familiarity of American Steel & Wire Company technicians with the structural forms of metals—and the application of these metals to spring design—has played an important part in the successful development and use of springs.

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levers 43 to curl the edge of the can end and seam it to the can body by engagement of cam arms 56, *Fig.* 1, with cams 37 and 38.

After the head has made a sufficient number of revolutions to result in a difference of one revolution in rotation between the head and cams, the high point of cam ring 39 engages plunger 96 closing the circuit energizing a relay and consequently solenoid 86, *Fig.* 1. This trips latch lever 82, thereby permitting rod 26 to raise under action of spring 81 to lower the table. Greater speed in seaming the cans can, of course, be obtained by utilizing a multiple head machine.

AN HYDRAULIC device has been patented by Elmer E. Wickersham for Caterpillar Tractor Co., San Leandro, Calif., to be employed on agricultural harvesters which are operated in hilly country. Because it is desirable to maintain the mechanism in a horizontal position during operation, this type of compensating or leveling unit offers interesting possibilities.

In order to govern the spacing between the body 6, *Fig.* 3, and the ground, there is provided by this patent, No. 1,941,143, an hydraulically expansible chamber 12 which is under the control of the operator through handwheel 37 and valve 36. The chamber is enclosed by a cylinder housing 13, the lower end of which is pivoted on crank axle 9 that supports wheel 8. Piston rod 18 carries a boss 21 for pivoting the

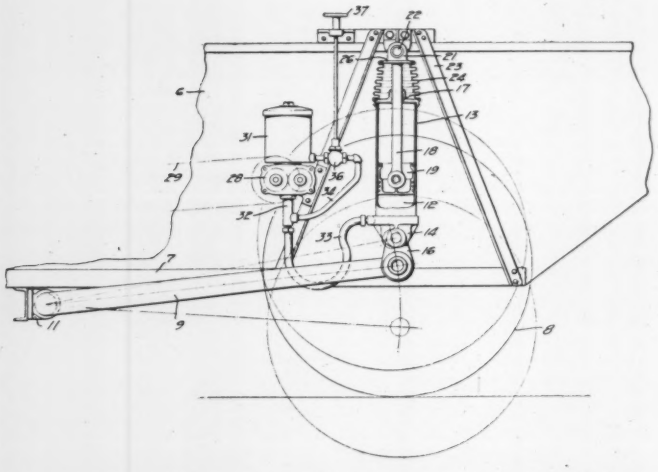


Fig. 3—Hydraulic device maintains harvester mechanism on level plane while machine is traveling on a hillside

piston rod at the apex of triangular superstructure 23 fastened to framework 7.

To form a guard for the sliding joint between the piston rod and cap 17, an expansible bellows-like member 24 is provided. The arcuate path of wheel 8 is compensated for by pivotal mountings 14 and 22, while stresses occasioned in the transmission of weight of the body to the wheel are carried by superstructure 23. Hydraulic pressure for the mechanism is furnished by pump 28. Since the pump ordinarily runs continuously during operation of the harvesting machine, a by-pass pipe 34 leads from the discharge side back to reservoir 31 through valve 36.

TO DEVELOP a lubricant pump wherein the discharge of liquid is uniform regardless of the speed at which it is driven, H. C. Roth utilizes a novel idea. Lubrication Corp., South Bend, Ind., is assignee of the patent, No. 1,941,141. From *Fig.* 4 it will be seen that the root of the

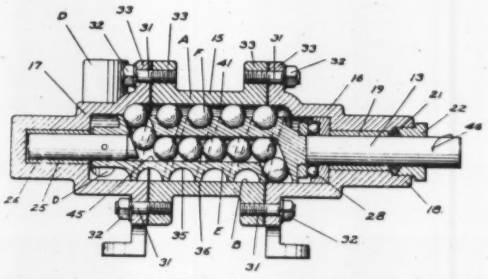
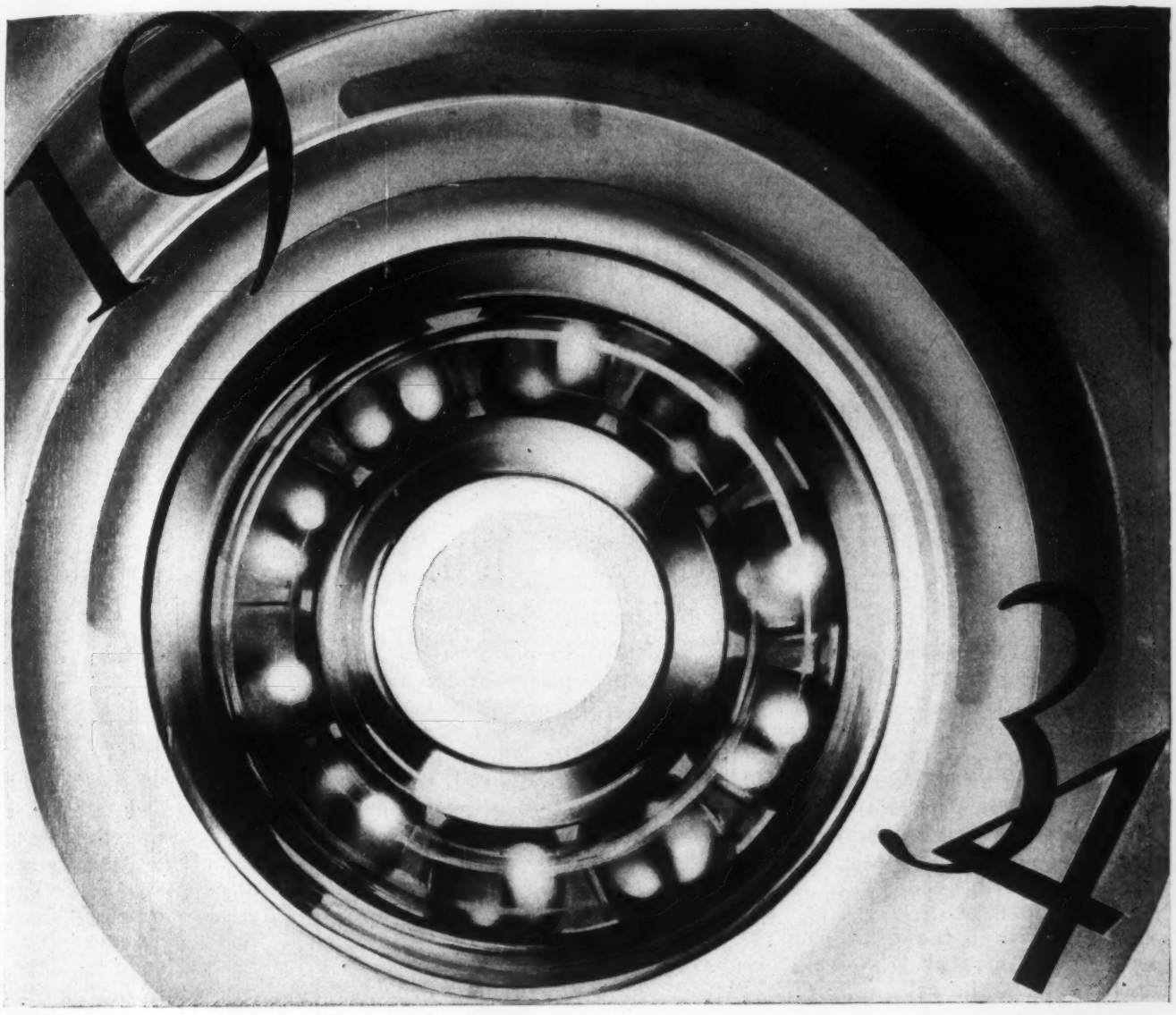


Fig. 4—Steel balls act as sealing members to minimize pressure losses in lubricant pump

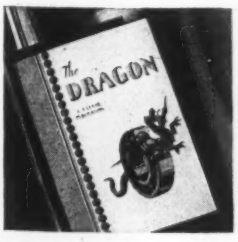
screw thread of the pump screw *E* is semicircular in cross section and the outer surface of the thread is flat, as indicated at 36. Internal diameter of pump chamber *B* is such as to effect engagement between the outer surface of the screw and the walls of the pump chamber.

For insuring positive pressure-producing characteristics in the pump, a depression 41 is formed in the side wall of the chamber *B* extending throughout the length of body 15 and into the head members 16 and 17. Steel balls *F* arranged between the threads of pump screw *E* are partially received in depression 41 and closely contact the side walls. As the pump screw is rotated, balls *F* are forced to travel along the longitudinal axis of the depression from one end of the chamber to the other, each ball serving as a seal between successive turns of the threaded portion of the pump screw shown in *Fig.* 4.

A series of bores are formed in the body of pump screw *E* comprising a passageway 45 communicating with opposite ends of the screw at its root on diametrically opposed sides of the screw. Passage 45 serves as a means through which the balls *F* may be returned from the discharge end of the pump screw to the inlet end upon completion of their forward movement. Positive high pressure characteristics are attainable through use of the steel balls which act as sealing members.



Let's roll on to Profits in 1934



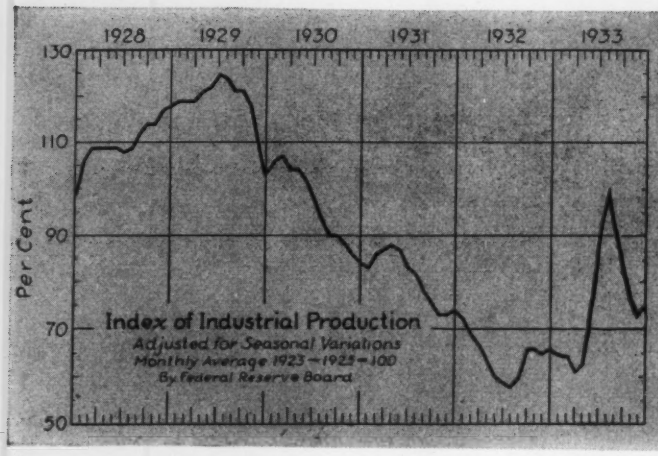
SAVINGS *through successful fighting of friction, in machines of all kinds on land and sea and in the air, are recorded in* "THE DRAGON". *We will gladly put your name on its mailing list. There's no obligation.*

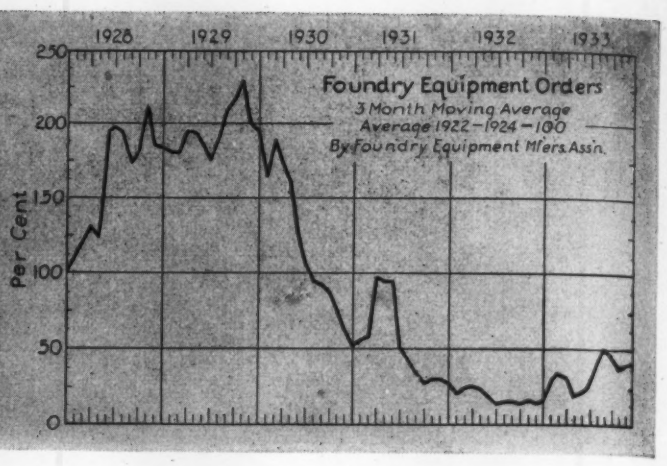
Waste is the enemy that 1934 will strive to conquer with increasing effort. In the form of friction it is one of industry's serious expenses, a handicap to sales and profits.

There's one attack which never fails —ball bearings. Machinery builders are marshalling these fighters of friction in ever-increasing quantities—and winning. To this success Fafnir is constantly contributing technical improvements in seals, housing and mountings.

In their efficient application the Fafnir engineering staff is at industry's command. Let Fafnir help you roll on to greater profits in 1934! THE FAFNIR BEARING COMPANY, *New Britain, Conn.*
Atlanta . . Chicago . . Cleveland . . Dallas . . Detroit . . Milwaukee . . Minneapolis . . New York . . Philadelphia.

FAFNIR BALL BEARINGS



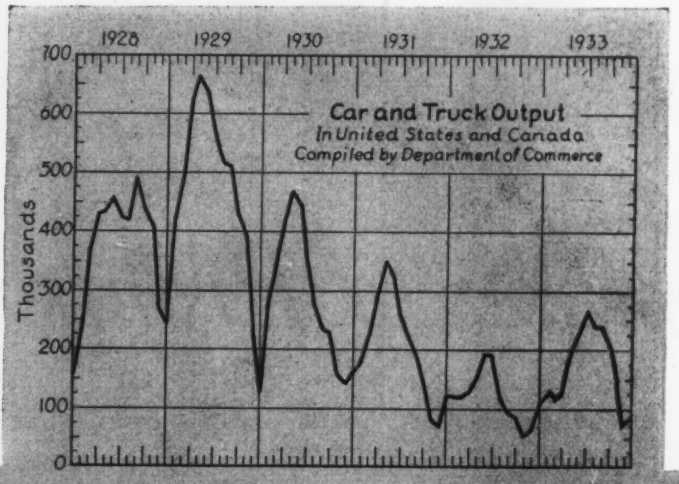


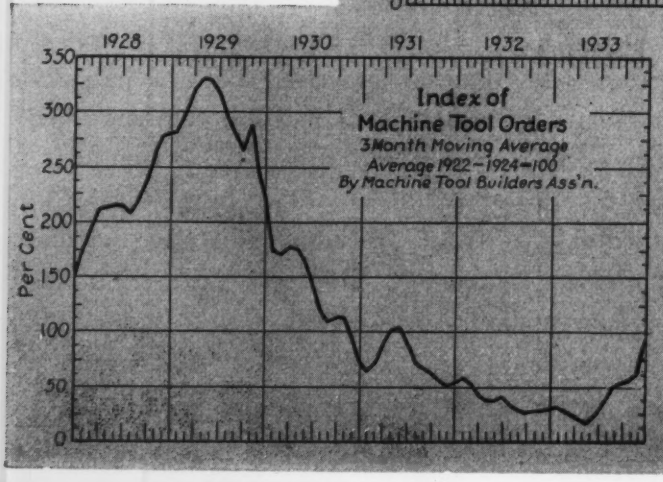
How Is Business?

DURING the closing weeks of 1933 and the first month of 1934 business has become better balanced than at any time since the depression started. Employment, department store sales, freight loadings, industrial production and building contracts are each fairly well balanced with respect to the others.

The machine tool industry, a group that came nearer to nadir than practically any other, has rebounded exuberantly during the past four months, reaching a higher point in December than any attained since September, 1930. The per cent of improvement has shown a steady acceleration, an acceleration due to the necessity for replacements in many manufacturing plants and the requirements of the automotive industry.

Industrial production is well above last year's figures despite the fact that production difficulties have materially delayed the automotive production lines. This delay also vitally affects steel production as expected orders have not been forthcoming with their usual celerity for this time of the year. Steel production is also suffering from lack of orders from the railroad industry, a group that is expected to enter the market in a short time. When these retarding factors have been lifted, industrial production will show even greater gains and help accelerate recovery.





MODERN MACHINERY CALLS FOR MODERN METALS

THE DRAMA OF TRANSPORTATION
PROVIDES MANY A ROLE FOR
NICKEL

SWIFTER and swifter grows the tempo of modern transportation... demanding machines and materials that must stand greater stresses, greater shocks, greater heat, and greater wear.

Superior metals are required to combat these destructive forces. And, thanks to Nickel, there is now available a versatile group of alloys which successfully meets these increased demands.

In locomotives, in airplanes, in ships, automobiles, trucks and busses—in every type of modern vehicle—alloys containing Nickel play a vital role... because they enable designer, engineer and manufacturer to suit the product more completely to present-day conditions and requirements.

When Nickel is correctly alloyed with other metals a wide range of improved properties is obtained—properties that assure increased resistance to heat, stress, fatigue, erosion, corrosion, abrasion and wear.

The alloys containing Nickel embrace a variety of compositions, each carefully determined by exhaustive laboratory and service tests. And wherever equipment is thoroughly modern you are certain to find Nickel Alloy Steels, Nickel Cast Irons, Nickel Bronzes, Stainless Steels, etc., serving a wide range of purposes.

Alloys containing Nickel prolong the life of cylinders and reciprocating parts of high-speed locomotives ...and make turbine blades, propellers and pump shafts more highly resistant to corrosion.

Truck, bus and car manufacturers employ them for engine blocks, brake drums, gears and transmissions... and applied to swift carriers of the air, they insure more dependable engine performance.

Not only in transportation but in every field where man uses metals, there is an alloy containing Nickel that can be employed to fill some particular role more efficiently and more economically.

Alloys containing Nickel are commercially available in all important metal consuming centers. If you are planning to build new equipment or modernize the old, our engineers will be glad to advise you concerning the most suitable applications.

Nickel Alloy Steels

Among the most widely used alloys containing Nickel are the Nickel Alloy Steels. Tons and tons are used in the transportation industry because of their exceptional toughness and strength, and their high resistance to stress, heat, pressure, shock and wear.

THE INTERNATIONAL NICKEL COMPANY, INC.

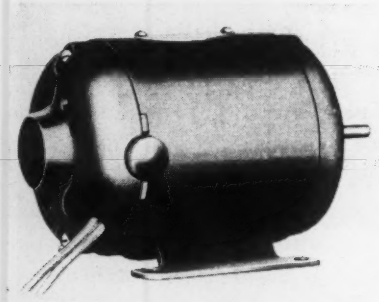
Miners, refiners and rollers of Nickel. Sole producers of Monel Metal.

67 Wall Street New York, N. Y.

NEW MATERIALS AND PARTS

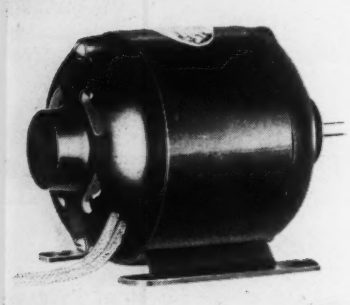
Improved Small Motors Announced

FRACTIONAL horsepower, series wound motors in a complete line have been announced by General Electric Co., Schenectady, N. Y., for use on office devices, portable appliances, etc. These motors, shown herewith and designated as type P, are available with universal characteristics in most speed ratings and permit the use of the same motor on either alternating current, 60 cycles and below, or direct current. Use of fabricated steel stator shells and die cast end shields make the motors light in weight. Compactnes of the design facilitates their use under special mounting conditions. The motors are available in ratings from 1/100 to 1/3 horsepower at speeds up to 10,000 revolutions per minute.



Fractional horsepower, series wound motors are available with universal characteristics

A companion line of fractional horsepower, shaded pole motors, designated as type KSP and

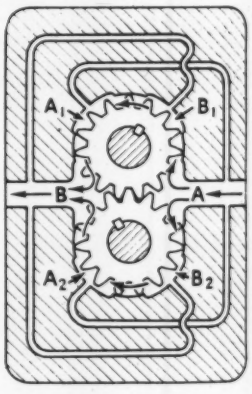


Shaded pole motors have spiralled rotor slots and cast aluminum squirrel cage winding.

shown in the accompanying illustration, has been developed by the company for use with a large variety of devices such as small fans and blowers, timing devices, thermostats, valves, etc. Fundamentally this is a quiet operating type motor incorporating improved mechanical features such as spiralled rotor slots and cast aluminum squirrel cage winding. The motor is available in any rating from 1/250 to 1/60 horsepower.

Hydraulic Pump Is Balanced

DESIGNED on the hydraulic balancing principle, the new gear pump and fluid motor introduced by Vickers Inc., Detroit, cannot bind or lock when used either as a pump or a motor.



Unit may be employed as a pump or as a motor and rotation is reversible without internal change

The accompanying sectional schematic drawing illustrates the principle of the device. Adjacent to the gears and diametrically oposite the inlet chamber A, are balancing chambers A_1 and A_2 which are connected to A and are open to its pressure. Similarly, balancing chambers B_1 and B_2 are connected to outlet chamber B and are open to its pressure. Each gear is therefore always in hydraulic balance, thus eliminating thrust loads and the consequent wear on bearings, gears and housing which increase slippage.

The unit may be used as pump or motor and

WHY PAY THE PRICE OF INDIFFERENCE?

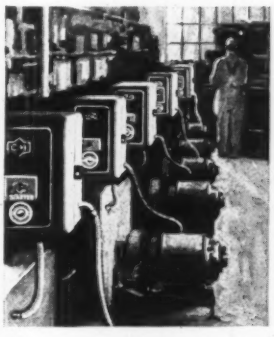
"BUT BOSS WE'VE GOT TO DELIVER!"

BROKEN delivery promises exact heavy penalties. Discouraged salesmen . . . infuriated customers . . . lost orders. Executives are quick to reject machines that cause their production to falter as sales improve.

Carelessly chosen or improperly applied Motor Control can cause such trouble. For Motor Control is the one link between human intelligence and motorized machines. It has a bearing on the speed and dependability of production, the quality of workmanship, the economy of operation, the cost of power and maintenance, the safety of men, motors and equipment.

Motor Control in size or cost may seem unimportant. But wise designers and builders of motor-driven machines know that the important part it plays in machine performance requires great care in its selection.

Standardize on Cutler-Hammer. Call in C-H engineers while designs are in the blueprint stage. You can use Motor Control as a sales feature as well as to insure performance of your machines. CUTLER-HAMMER, Inc., *Pioneer Manufacturers of Electric Control Apparatus,* 1310 St. Paul Ave., Milwaukee, Wis.



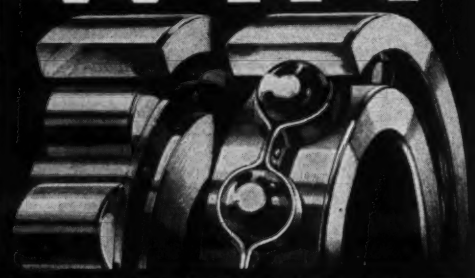
The designing and building of Motor Control is a separate and distinct division of electrical engineering. The place to go for consultation and advice on Motor Control problems is to a control specialist. Cutler-Hammer indisputably qualifies as such a specialist. Your problems will be welcomed here. A letterhead request brings the C-H Catalog.

NRA MEMBER U.S. WE DO OUR PART

CUTLER HAMMER

The Control Equipment Good Electric Motors Deserve

(A-8028)

TWIN

PRECISION

IN the past 20-odd years many standards have become flexible, and quality has—in many cases—become a variable thing . . . But throughout this period NORMA-HOFFMANN Precision Bearings have been consistently made to the highest standard of excellence . . . They continue to be the choice of those who measure value by service rendered, and who seek the lowest cost per bearing per year of useful life . . . *Write for the Catalog. Let our engineers work with you. . . . . .*

"NORMA-HOFFMANN"
PRECISION BEARINGS
BALL, ROLLER AND THRUST
NORMA-HOFFMANN BEARINGS CORPORATION,
STAMFORD, CONN., U. S. A.

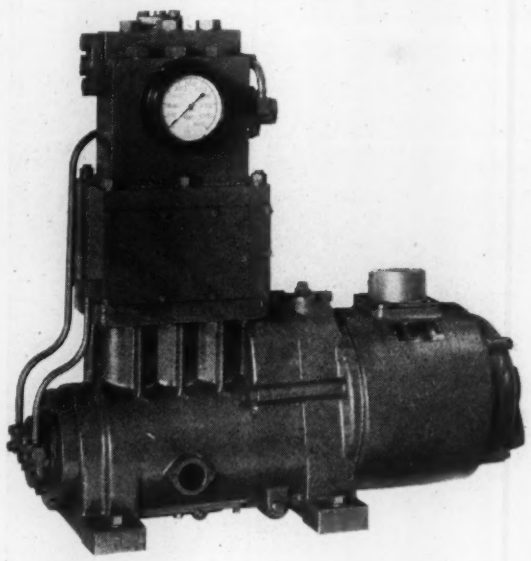
rotation is reversible without internal change. It has been used as a motor to drive drills, grinding spindles and a variety of other applications.

Develops Portable Drawing Machine

DEVELOPED to furnish a small drawing unit which can be carried conveniently in a brief case or used at home, on the train or elsewhere, the Wrigraph draft block being offered by Fletcher F. Milligan Co., 4626 Prospect avenue, Cleveland, is a machine which eliminates tee squares and triangles. The unit consists of a board and parallel device with drawing attachment. The board is equipped with clips which will hold either a single sheet or a pad of letter size paper. Either of two drawing attachments is provided—a combination of the 30-60 and 45-degree triangles into one, or a protractor and a graduated straight edge which can be set by degrees to any angle required.

Hydraulic Unit Is Self-Contained

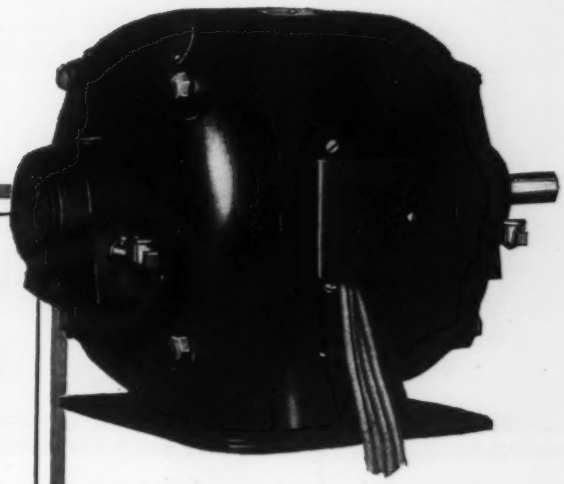
POSSIBLE of installation as an integral part of an hydraulic machine and particularly adapted to continuous duty, a complete self-contained hydraulic triplex power unit has been developed by Kobe Inc., Huntington Park, Calif.



Hydraulic machine assembly includes a self-contained relief valve

The unit, shown herewith, is designed along the lines of a vertical automotive power plant and is mounted on antifriction bearings throughout. Pump drive and motor are completely self-contained and enclosed, no gears, belts or shaft connection being exposed.

Units are made in sizes of 3, 7½ and 15 horse-



Type SCR (illustrated) ½ to ¾ hp. Also available in sizes through 10 hp. Type RSA 1/6 to 1/3 hp.

TO DESIGNERS WHO NEED COMPACT, RELIABLE SMALL MOTORS FOR HEAVY JOBS

General Electric Type RSA and Type SCR fractional-horsepower motors provide compact, dependable "packages of power" for jobs that require a maximum of starting and accelerating torque — applications where the machine must be started under overload starting or running conditions, or where the voltage may be low.

NRA MEMBER U.S. WE DO OUR PART

JOBS like these, for example . . .

COMPRESSORS, having a high initial starting load need the exceptional starting ability of the Type RSA and the Type SCR motors. Their output-torque curve matches the load-torque cu ve of the compressor — no need to over-motor.

FLOOR-SURFACING MACHINES, which are subject to heavy peak loads, due to variations in the surface conditions, and which are also subject to low-voltage conditions because of the long portable cords used. These motors were developed to meet operating conditions such as these.

SLICERS, GRINDERS, and CHOPPERS used in food-products industries, which must handle high momentary overloads and must be brought up to speed quickly. Here, again, the excellent electrical and mechanical adaptability of the Type RSA and the Type SCR makes them the RIGHT motors for the job.

Why not avail yourself of our specialized engineering service in perfecting motorized machines? General Electric, Dept. 6A-201,Schenectady, N. Y.

070-16

GENERAL ELECTRIC

It is generally conceded . . . . .

that Leland engineers have found the best way—not to boil an egg—but to make a motor operate quietly.

To achieve quietness in a motor, Leland gives it a resilient flange mounting to make transmission of noise and vibration through to the motor support impossible.

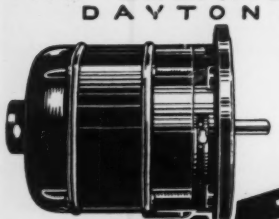
In addition to making the motor quiet in operation, this type of mounting insures against shaft misalignment due to any of the various thrusts—important.

Make the Leland test. Clamp one of these resilient mountings in your vise. Interpose solid metal, a screw driver for instance, between the base and the resiliently supported frame. Then remove the screw driver and note the unbelievable difference.

A. C. Repulsion-Induction
D. C. and Polyphase
Ratings 1/8 to 3 h. p.
Interchangeable frames
Specials where required

THE LELAND ELECTRIC CO.
DAYTON · OHIO · U·S·A

CANADIAN ADDRESS
TORONTO
CABLE ADDRESS
LELECT



Leland Motors

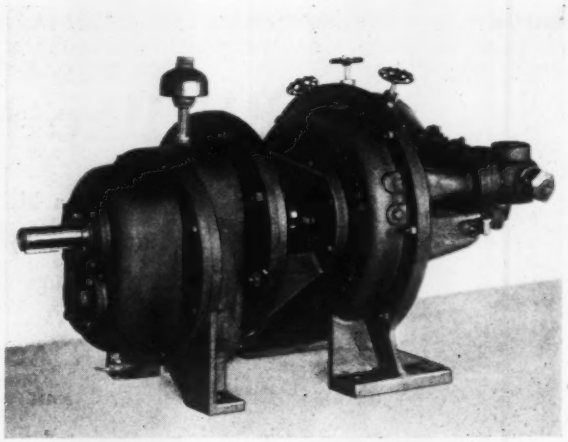
Some additional Leland Designs

Split Phase motors
Explosion-resisting motors
Standard reversible motors
Instantly reversible motors
Brush-shifting variable speed reversibles
Geared Head motors
Fan Cooled motors
Capacitor start-capacitor run motors
Capacitor start-Induction run motors
Motor generator sets
Generators
Self-excited alternators and inverted converters

power and displacements of 1 to 12½ gallons per minute for continuous pressure duties of from 500 to 5000 pounds per square inch. For intermittent duty these pressures can be considerably exceeded. The complete assembly includes a self-contained relief valve and an operating pressure gage. Lubrication is positive and automatic from a 30-pound pressure system, while lubricating oil and hydraulic medium are maintained separately. Plungers are packless and any slippage is returned positively to the supply. Parts in the hydraulic end of the unit are made from stainless and corrosion resisting materials. Valves and valve seats are hardened and ground.

Reducers Are Built into Turbines

BUILT-IN speed reducers combined with steam turbines are a recent innovation of Coppus Engineering Corp., Worcester, Mass. The built-in reducers can be supplied with either single reduction or double reduction units, and for clockwise or counterclockwise rotation. These machines, shown herewith, are compact



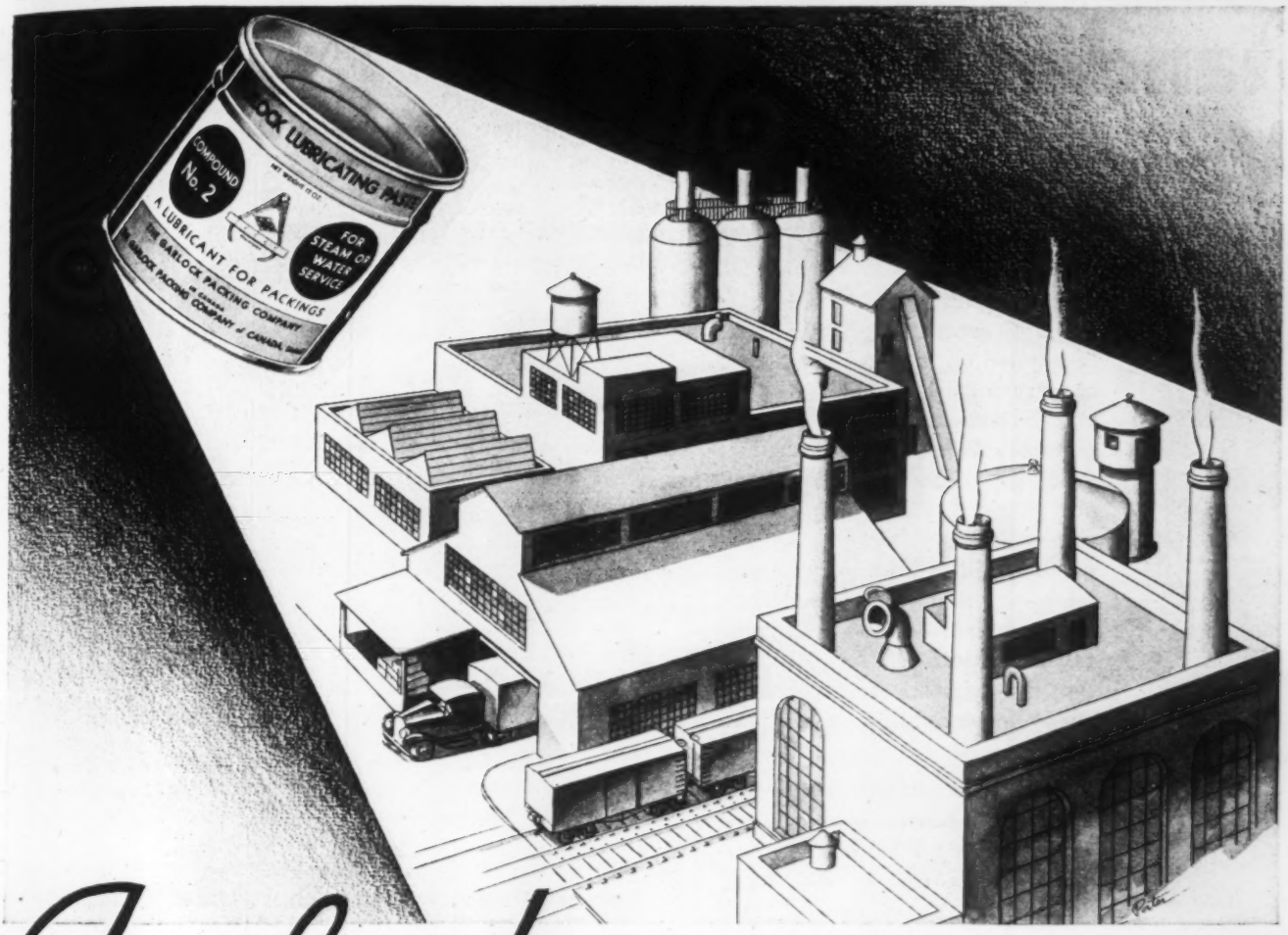
Combined turbine and reducer is available with single or double reduction

in design, requiring little floor space in installations. All gears in the single and double reduction units are of the herringbone type which is best suited for the speed reducer type of drive in which high primary speeds are used. The units have been applied to pumps, blowers, mixers and similar machinery.

Dust Tight Switches Introduced

COMPACT switches in dust tight and weatherproof cast iron enclosures have been added to the line of controls manufactured by Switch & Panel division, Square D Co., 6060 Rivard

A NEW LIGHT ON YOUR PACKING PROBLEMS



Garlock LUBRICATING PASTE

IF you reduce friction to a minimum you improve the performance of your packings and lengthen their life . . . in fact, you solve one of your most perplexing packing problems.

Here's new light for you on this subject. Garlock has developed Lubricating Pastes which reduce friction to a minimum, increase the efficiency of packings and prolong their life.

GARLOCK LUBRICATING COMPOUND NO. 2 is for application to rod or plunger packings operating against steam, hot or cold water and non-oily chemicals. Resists heat and maintains proper viscosity . . . water and steam proof . . . prevents rust and corrosion.

GARLOCK LUBRICATING COMPOUND NO. 3 is for packings working against gasoline, benzine, oils, ether, carbon tetrachloride, kerosene, diphenyl, and all vapors and chemicals of an oily nature.

For maximum packing efficiency and long packing service apply Garlock Lubricating Pastes to your packings at regular intervals! Supplied in 12 oz., 24 oz. and 5 lb. cans; also in bulk.

Place a trial order NOW!

THE GARLOCK PACKING COMPANY, Palmyra, New York

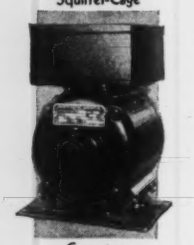
In Canada: The Garlock Packing Company of Canada, Limited, Montreal, Quebec

GARLOCK

You can Standardize on Wagner Motors

Repulsion-Start-Induction

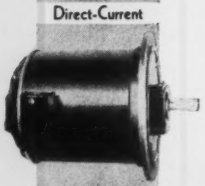
Squirrel-Cage



Capacitor

Split-Phase

Direct-Current



Flange-Mounted

Vertical

The Wagner line includes all types of small motors generally applied on motor-driven machinery, making it possible for you to standardize on Wagner motors. Whether alternating or direct current; single or polyphase; open, drip-proof, totally enclosed or explosion-proof; rigid or resilient-mounted, flange-mounted or built-in; sleeve or ball-bearing; horizontal or vertical—there's a Wagner motor now in existence, ready to be applied on the job.

There are 25,000 different type-horsepower-speed combinations of Wagner motors (in ratings up to 400 hp). Certainly, your motor requirements are no greater than that!

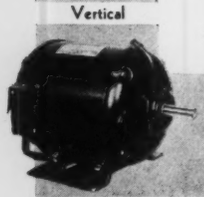
For complete details, ask for Bulletin 167 describing Wagner small motors.

Wagner Electric
MOTORS
TRANSFORMERS
FANS BRAKES

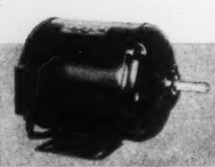
Wagner Electric Corporation
6404 Plymouth Ave., St. Louis, Mo.
Gentlemen;
Please send copy of Bulletin 167 on small motors

If interested also in large motors, indicate here ☐

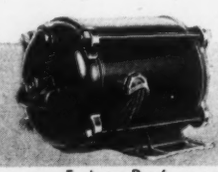
Name and Position _____
Firm _____
Address _____ S433-1B



Resilient-Mounted



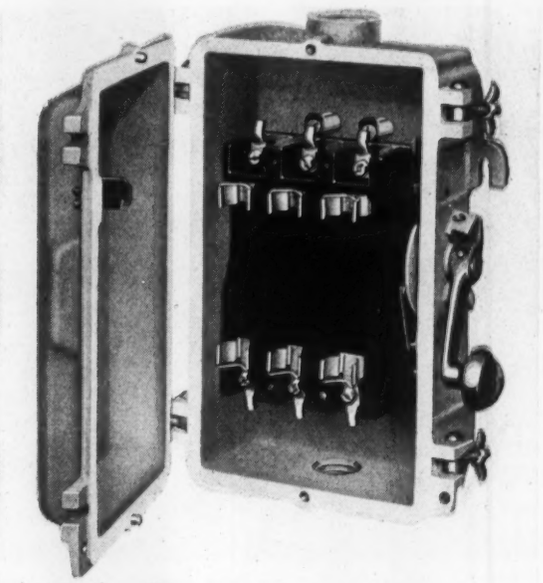
Drip-Proof



Explosion-Proof

street, Detroit. The new switches, shown herewith, have the same features as the company's 50,000 series, quick make, quick break, interlock and easily removable base which is elevated from the back of the box to permit wiring under the base.

This line is available in 30 and 60 amperes

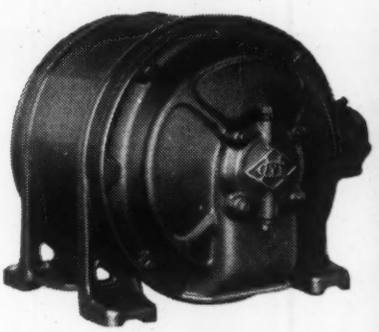


Switches are featured by quick make, quick break, interlock and easily removable base

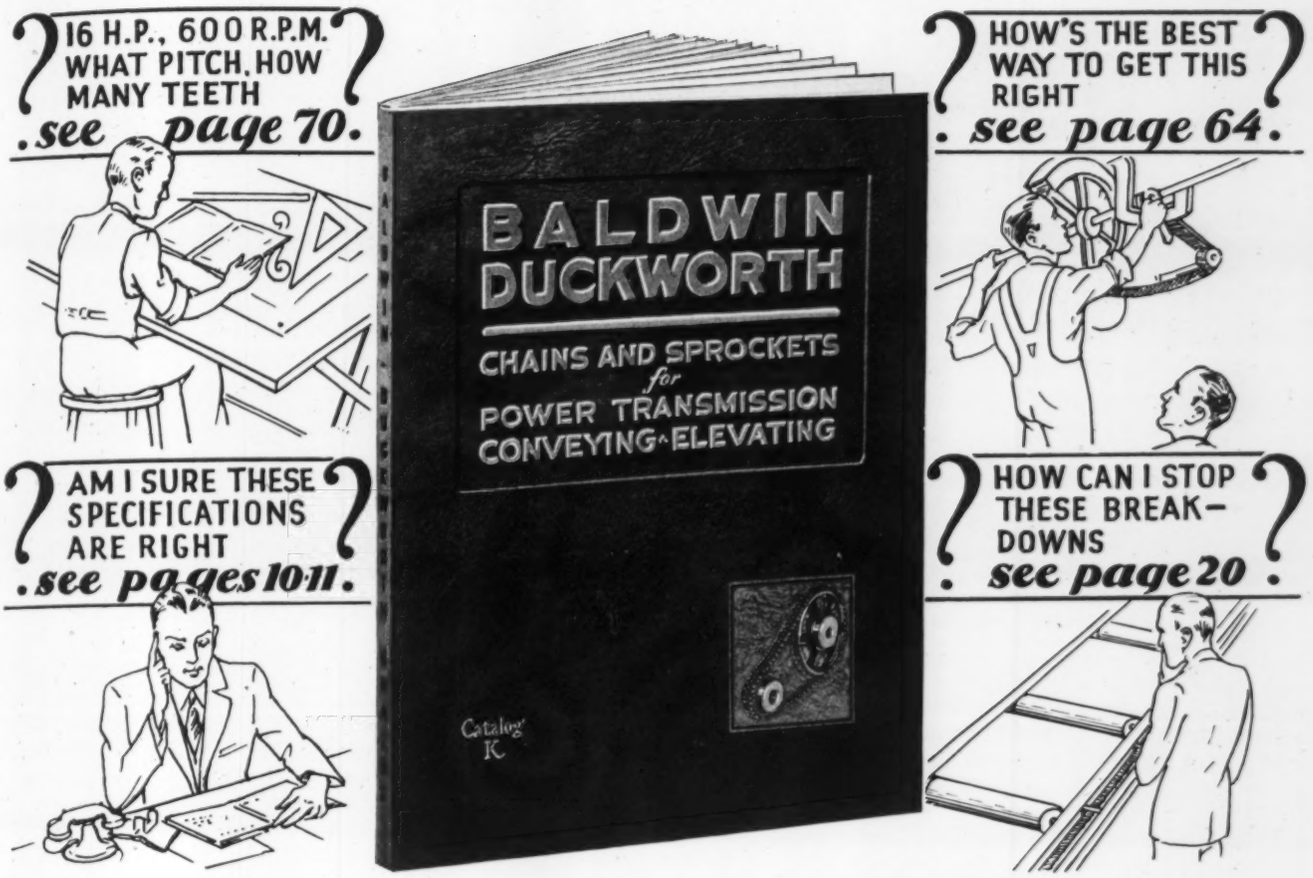
and will be manufactured in 100 and 200-ampere sizes within a short time. The line includes two and three-pole, three and four-wire solid neutral and three-wire switches neutral fusible and nonfusible in both low and high voltage.

Motor Cases Keep Out Moisture

DESIGNED for protection against falling or splashing water, the new line of motors announced by Marble-Card Electric Co., Gladstone, Mich., is recommended by the company for machines that are to be used in packing plants, laundries, breweries, paper mills and other places where falling or splashing water or



Splashproof motor is fully enclosed except for small openings on the lower side of each end plate


16 H.P., 600 R.P.M. WHAT PITCH, HOW MANY TEETH
.see page 70.
HOW'S THE BEST WAY TO GET THIS RIGHT
. see page 64 .
BALDWIN DUCKWORTH
CHAINS AND SPROCKETS for POWER TRANSMISSION CONVEYING ELEVATING
Catalog K
AM I SURE THESE SPECIFICATIONS ARE RIGHT
.see pages 10-11.
HOW CAN I STOP THESE BREAK-DOWNS
. see page 20 .

This BOOK *has all the* ANSWERS

Power transmission and conveying jobs bristle with questions — questions by draftsmen, by engineers, by millwrights, by purchasing agents. Now, *for the first time, every conceivable question has been answered, in advance, and the answers put in one compact manual.*

Don't you want to get these *answers* today and they will be at your elbow when the questions come up, as they surely will? All you need do is tear off the bottom of this page, mail it to us, and by return mail you'll receive the new Baldwin-Duckworth Chain and Sprocket Book.

BALDWIN DUCKWORTH

Factories at Springfield and Worcester, Massachusetts

Baldwin-Duckworth Chain Corporation,
365 Plainfield St., Springfield, Mass.

Please send me a copy of your new Chain and Sprocket Catalog K.

Signed.....

City.....

State.....

DUMORE—
The World's Finest Small Motors

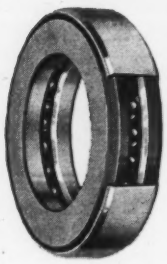
In every detail of their construction Dumore Fractional Horse Power Universal Motors are the finest available. They can be supplied in any size up to ¾ H. P. and can be adapted to a wide variety of applications. Regardless of what your requirements may be, ask for technical data regarding the construction and performance of Dumore motors before deciding.

DUMORE COMPANY
100 Sixteenth St., Racine, Wis.

DUMORE
FRACTIONAL HORSEPOWER
MOTORS

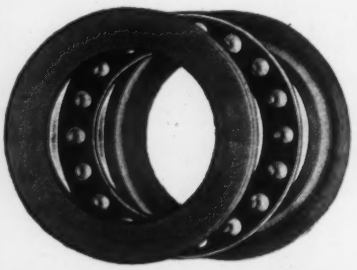
BANTAM BALL AND ROLLER BEARINGS

Standard and Special Sizes For All Types of Machine Application



¶ BANTAM has manufactured the WORLD'S LARGEST BACKING ROLL BEARINGS (51" O.D.) for steel mills and the smallest Quill Rollers (.050" Diameter). Our experience and facilities enable us to serve you efficiently and economically.

Ball and Roller Bearings from ½" to 60" in diameter. One or one hundred million.



36TH YEAR

Write for BANTAM Ball and Roller Bearing Manual No. 11. Also 12-page booklet of Engineering Data on Quill Bearings.

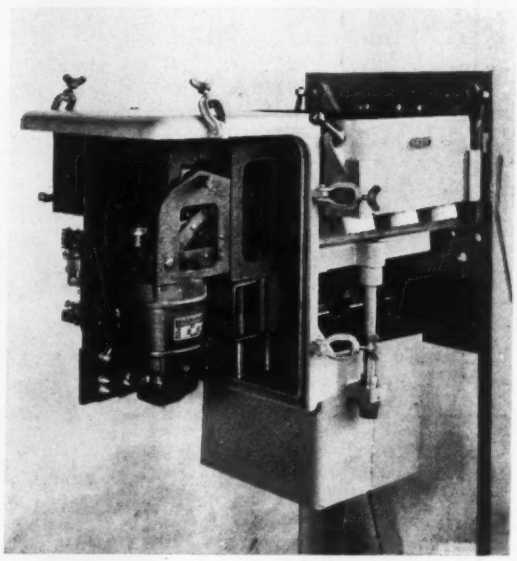
8BB
TRADE MARK REGISTERED

Bantam Ball Bearing Company
South Bend, Indiana

dirt is likely to damage the motor. The new protected type motor, shown herewith, is fully enclosed excepting for small openings on the lower side of each end plate which are so designed that splashing or falling water cannot enter the motor. An efficient cooling system makes possible the use of the same frame sizes for splashproof motors as for open type motors of equal rating. The company manufactures the new motors in both single phase and polyphase squirrel cage types up to 30 horsepower.

High-Speed Motor Controls Offered

HIGH-SPEED motor operators for application to small switchboard type oil circuit breakers and to subway and pole line oil switches have been introduced by Condit Electrical Mfg. Corp., Boston. The new operator, shown herewith and



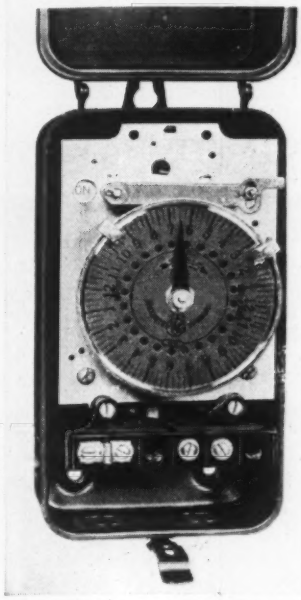
Closure can be accomplished in approximately eight seconds

designated as type UC-30, is compact and simple. It consists of a universal motor directly connected through a trip-free mechanism to the oil circuit breaker. Closure can be accomplished in approximately 8 cycles. The motor is suitable for operation on 110 or 220 volts alternating current, 25 or 60 cycles, and 48, 125 and 250 volts direct current. It is especially suitable for automatic throwover and automatic reclosing service.

Indoor Time Switch Is Announced

INTENDED for indoor service, the type T-15 automatic time switch has been developed by General Electric Co., Schenectady, N. Y., as a

companion switch to the type T13 general-purpose automatic time switch. The new control, shown herewith, has no cover gasket, is finished



Mercury-to-mercury switches and timing by electric clocks feature new automatic time switch developed for indoor service

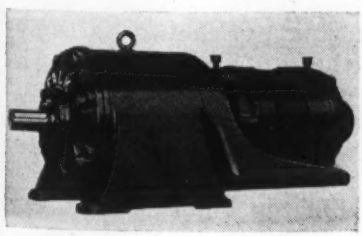
in black lacquer, and is with or without a window in the case; in other respects it is identical in time and switching design with the type T-13.

The new 30-ampere switch is available in 12 forms—with or without a device for skipping operation on certain days, for either 115 or 230 volts, and for single-pole, single or double-throw, or double-pole, single throw.

Features of the unit are the use of a Telechron motor, as used in electric clocks, for timing the device; and the employment of mercury-to-mercury Kon-nec-tor switches. Two adjustable riders ("on" and "off") give two operations every 24 hours; additional riders may be installed to give more operations daily.

Any Motor Can Be Used with Reducer

UTMOST freedom in choice of motor is allowed the user of the new all-motor, type Z, Motoreducer brought out by Falk Corp., Mil-



An entirely standard horizontal motor without change can be used with reducer unit

waukee. The design differs from the all-motor type previously introduced in only one detail. The ledge that supports the motor instead of

Here's the Answer to

YOUR GAUGE PROBLEMS!

If your product requires gauges, it will pay you to talk with a Marsh Engineer. He will tell you how Marsh Gauges have helped many leading manufacturers improve efficiency and show substantial savings, too. You will find him prepared to answer any gauge problem and able to give you sound advice in the selection of gauge equipment. Mail the coupon below for our new complete catalog and get acquainted with the Marsh line—the finest gauges built!

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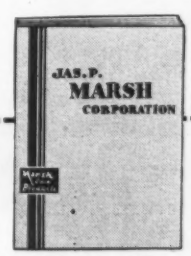


Shows the complete Marsh Line—a Gauge for every application

Gentlemen: Kindly send me a copy of your new catalog on Marsh Gauges.

Firm Name .....

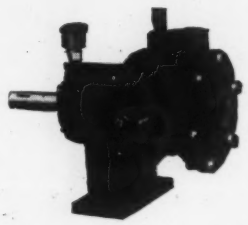
Address .....

Signed by .....

☐ Check here if you wish a Marsh Engineer to call on you.

MAIL THIS COUPON TODAY!

Note These Advantages of VIKING Coolant Pumps



Incorporates the world-famous Viking "Two-Moving Parts" Principle . . insuring low power requirements and long life.

Made only of the finest laboratory-tested metals in capacities of 5, 10, 15, 20 and 35 G.P.M.

Built-in relief rotor to act as relief valve when the oil line is shut off.

Ports are tapped and plugged to permit changing the direction of rotation. Each port is drilled for the "suck-back" feature . . with one short and one long plug. To change the direction of rotation merely reverse the position of the plugs.

Efficient, reasonably-priced . . easily adapted to a wide range of applications. Write for Special Bulletin.

VIKING PUMP COMPANY
Cedar Falls, Iowa

"THESE BW PRINTS HIT ME RIGHT!"

. . . "They're far easier to read and to check. Pen or pencil notes show up clearly on the white background. And we can get BW Prints as quickly and as easily as blue prints."

Bruning BW Prints are Black And White Positives—made *without the use of a negative*. Your Bruning dealer can supply them, or you can produce them in your own blue printing department with a simple, inexpensive BW Developing Machine.

Investigate BW Prints. Write us for complete information.

The BW Process, Paper and Cloth are protected by U. S. Patents No. 1821281 and No. 1841653. The BW Machines, U. S. Patent No. 1891722, are for exclusive use with the BW Process.

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Since 1899

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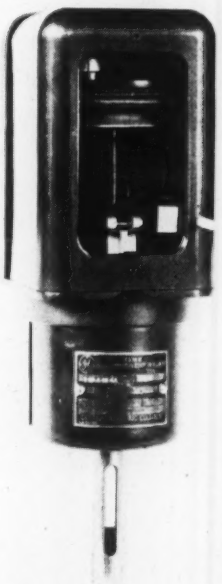
BRUNING

being made integral with the gear housing is in the form of a separate adapter which is rigidly fastened to the housing. This construction is especially useful for large reductions in which the motor is relatively smaller than the gear case. An entirely standard horizontal motor without change can be employed.

Relays Regulate Current Changes

INSTANTANEOUS and time delay plunger-type relays in a complete line for protection against overcurrent and undervoltage and for use as auxiliary relays have been announced by General Electric Co., Schenectady, N. Y. The same principle of operation is common to the entire line and depends upon the action of a magnet coil in attracting and releasing a plunger when predetermined values of voltage or current are present in the coil circuit.



Relay can be changed from time delay on contact opening, contact closing, or both, by simply placing a popet in the proper hole

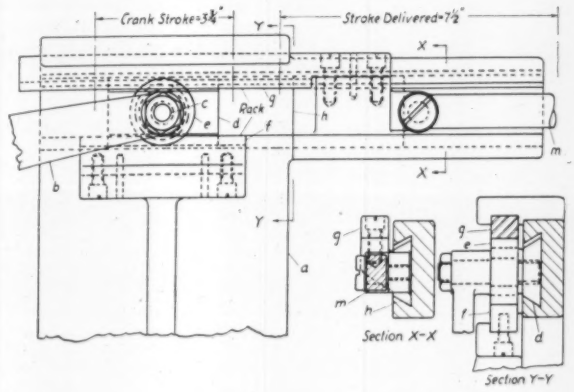
The mechanical design is unique, as the relays are all single-pole and include a variety of adjustments and convertible features. The instantaneous overcurrent relay, shown herewith, can be changed from time delay on contact opening, contact closing, or both, by simply placing a poppet in the proper hole. Likewise, by turning a cap, the air intake or out-take to the bellows can be regulated to change the time delay in the opening or closing of the contacts. The bellows of the time delay are made of superaging rubber which does not require lubrication and which is unaffected, either in its action or durability, by high or low temperatures. Other features include the changing of hand-reset to self-reset contacts, and from circuit opening contacts to circuit closing contacts.

PROFESSIONAL VIEWPOINTS

(*Continued from Page* 37)

nary crank and slide arrangement, suitable work fingers being attached to the slide. The work is deposited upon these fingers as it leaves the heating chamber and is immersed and swept to and fro in the bath until cooled.

Ordinarily, to obtain the additional slide movement, the crank could be made twice as long. However, the position of the crank in the machine prohibited this because of insufficient space. In addition to this, the crank was used to impart a movement to another member, consequently its throw could not be altered. As a



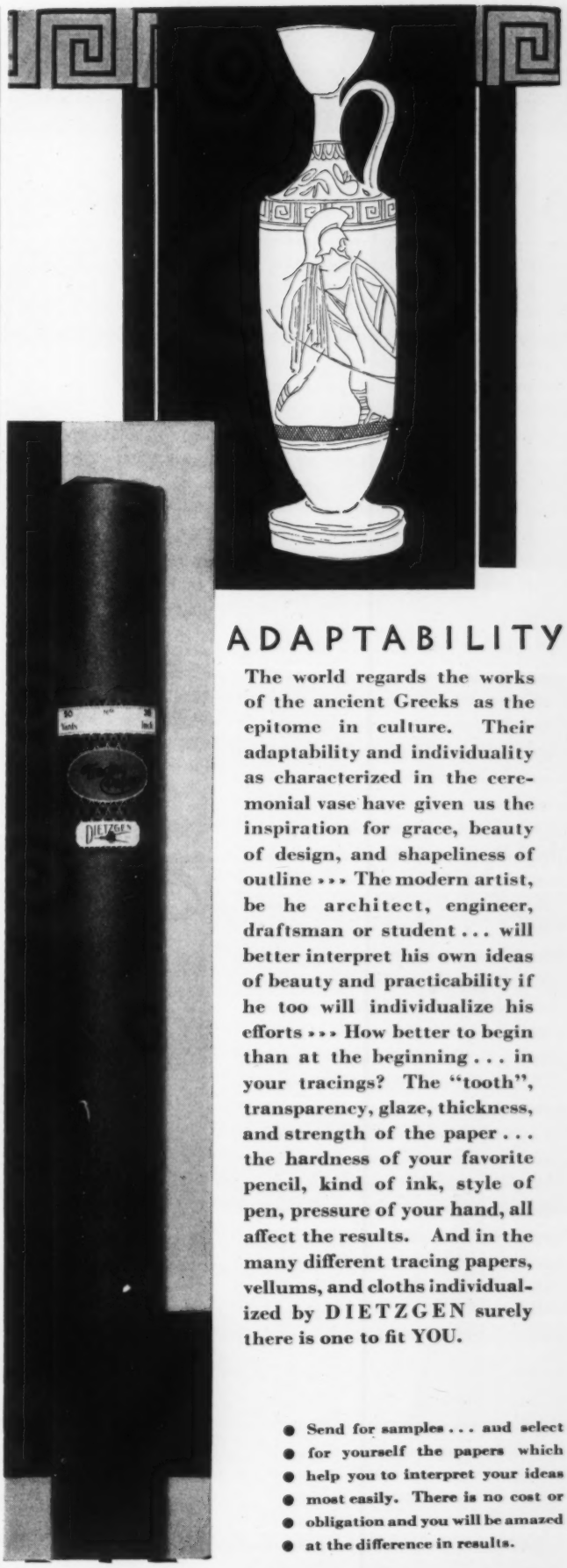
Additional slide movement is obtained by stroke-doubling mechanism

result, the mechanism shown herewith was interposed between the crank pin and the finger slide (not shown) in place of the original connecting rod.

The entire stroke-doubling arrangement is mounted on stationary bracket *a* which is bolted to the machine. The left end connecting rod *b* is connected to the crank while the other end is pivoted on the stud *c*, mounted on slide *d*. Pinion gear *e* is free to turn on this stud and meshes with the short stationary rack *f* screwed to the bracket and with the longer rack *g* attached to slide *h*. This slide utilizes the same dovetail guideway as slide *d* and has pivoted to its right end auxiliary rod *m* connected to the finger slide. It will be observed, by referring to section view *y-y*, that the longer rack which moves with slide *h* is guided in its path by a groove in bracket *a*.

The action of the device is simple. The crank-driven rod imparts a movement to the slide of 3¾ inches. Now, since gear *e* rolls on stationary rack *f*, rack *g* with slide *h* must travel twice the distance slide *d* moves. Since rod *m* is connected to slide *h*, the finger slide will move twice the original distance traveled, thus fulfilling the requirements.

—J. E. FENNO,
Belleville, N. J.



ADAPTABILITY

The world regards the works of the ancient Greeks as the epitome in culture. Their adaptability and individuality as characterized in the ceremonial vase have given us the inspiration for grace, beauty of design, and shapeliness of outline ››› The modern artist, be he architect, engineer, draftsman or student ... will better interpret his own ideas of beauty and practicability if he too will individualize his efforts ››› How better to begin than at the beginning ... in your tracings? The "tooth", transparency, glaze, thickness, and strength of the paper ... the hardness of your favorite pencil, kind of ink, style of pen, pressure of your hand, all affect the results. And in the many different tracing papers, vellums, and cloths individualized by DIETZGEN surely there is one to fit YOU.

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- for yourself the papers which
- help you to interpret your ideas
- most easily. There is no cost or
- obligation and you will be amazed
- at the difference in results.

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Eugene Dietzgen Co., Manufacturers of Drafting and Surveying Supplies
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San Francisco Milwaukee Los Angeles Philadelphia Washington
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ALLOYS (HARD FACING)—Materials that are particularly resistant to abrasive wear, and the hard facing process whereby these materials are applied to wearing surfaces to give them longer life are discussed in an exceptionally well-prepared 96-page booklet of Haynes Stellite Co., Kokomo, Ind. Applications to machinery used in a large number of industries are discussed and attractively pictured. The booklet also includes a presentation of the hard facing procedure and a description of the company's products.

BEARINGS—The grooving of oil-lubricated cylindrical bearings is treated in a comprehensive booklet of Socony-Vacuum Corp., New York. The booklet includes a complete engineering discussion of the subject as well as drawings which illustrate correct and incorrect methods of grooving and a table giving the correct fundamental method of grooving for each type of bearing.

BEARINGS—Compiled for the use of engineers and machine designers, the new 266-page *Engineering Journal* being distributed by Timken Roller Bearing Co., Canton, O., contains technical data on ratings, load calculations, bearing selection and other information pertinent to the mounting and use of roller bearings. Information is included on steep angle bearings, NA double cup bearings, multiple row bearings, and the flanged bearings. One section of the book is devoted to an explanation of bearing ratings along with the methods of calculating loads and selecting bearings. The book is for distribution to executives and engineers responsible for design.

BRONZE—Free cutting phosphor bronze and nickel silver, available as rods, strip, wire, bars, sheets and blanks, is presented in a recent folder of Riverside Metal Co., Riverside, N. J. The folder describes the materials gives outstanding characteristics and indicates applications.

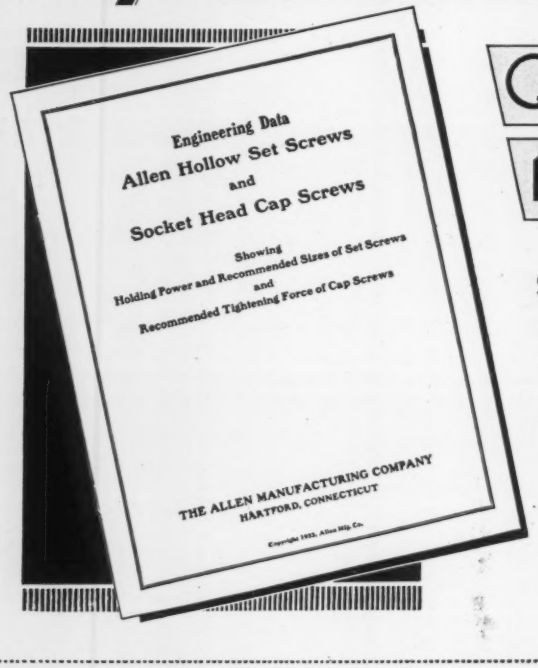
CAST PARTS—New Jersey Zinc Co., New York, is distributing loose leaf binders and copies of *The New Jersey Zinc Alloy Pot* to engineers and designers. The publication contains information on die castings and applications of these die castings to machines.

CONTROLS (ELECTRICAL)—Switches, panels, motor controls and miscellaneous products are included in the recently prepared abridged catalog of Diamond Electric Mfg. Co., Los Angeles.

CONTROLS (ELECTRICAL)—Complete details on the line of compact switches in dust tight and weatherproof cast iron enclosures is given in bulletin No. 201 of Switch & Panel division, Square D Co., Detroit.

CONTROLS (ELECTRICAL)—Ward Leonard Electric

Draftsmen and Engineers!



Get this valuable addition to your Handbook—*FREE*

Shows in tabular form the HOLDING POWER of Hollow Set Screws, with recommended sizes for specific uses. Also gives recommended tightening force of Socket Head Cap Screws, with references to service stresses. . . *This FIRST* textbook on the subject has been prepared by a prominent engineering firm for the Allen Company—primarily to help our friends and customers in making scientific selections of hollow screws. It should save the expense of experimenting with various sizes or styles; should forestall machinery breakdowns due to faulty selections or specifications. . . The booklet is yours with our compliments; use the Coupon at left. » » » » » »

Send ALLEN Engineering Handbook Data to
(Name).....
(Company Address).....
(Town and State).....

THE ALLEN MFG. COMPANY
HARTFORD, CONN. U.S.A.

Co., Mount Vernon, N. Y., is distributing catalog insert sheets on: sensitive relays for direct current operation; Vitrohm dimmers of the interlocking type; and sliding contact rheostats.

DRIVES—Constant tension is maintained on the motor belt by the motor bases described in four new publications of Rockwood Mfg. Co., Indianapolis. The bulletins present bases for small motors; standard driving bases; vertical drive bases, an adaptation of the standard base; and ceiling drive bases, an improved design for mounting motors overhead.

FASTENINGS—Engineering data on hollow setscrews and socket head cap screws is included in a new bulletin of Allen Mfg. Co., Hartford, Conn. The bulletin includes tables and charts and gives holding power and recommended sizes of setscrews and recommended tightening force of cap screws.

MOTORS—Sterling Electric Motors Inc., Los Angeles, is distributing a folder on its line of motors which have herringbone rotors and micabestos insulated windings.

MOTORS—Improved split phase motors manufactured by Emerson Electric Mfg. Co., St. Louis, are described in a recent bulletin of the company. The bulletin gives performance characteristics, and illustrates and describes design features of the motors.

PACKING GLANDS AND PACKING—Metallic packing for use in connection with steam, air, gas, gaseous ammonia and carbon dioxide equipment is shown in a new 36-page catalog of American Metallic Packing Co., Pittsburgh. Drawings and photographs illustrate the different styles of packing rings available.

SHAPES—Union Drawn Steel Co., Massillon, O., has prepared a folder on its line of cold drawn steels entitled "Making Steel Machinable." The folder describes the steel and outlines methods of production.

SPRINGS—Presented as an aid in facilitating the routine mathematical part of spring design, the new design chart for helical springs published by Wallace Barnes Co., Bristol, Conn., applies directly to steel extension or compression springs of round wire. With a slight modification, it can be used for other materials as well. The chart gives load at 100,000 pounds per square inch fiber stress, corrected for curvature; inches deflection per pound of load per active coil and recommended proportions of the spring.

WELDED PARTS AND EQUIPMENT—"Machine Gas Cutting—The Key to Better Design, Faster Production, Sweeping Economies," is the title of an attractive 92-page booklet being distributed by Air Reduction Sales Co., New York. The booklet includes a most comprehensive discussion of machine gas cutting, presents many applications pictorially, describes and pictures machines for doing the work, and gives the type of applications for which each machine is best suited.

PROOF OF SATISFACTORY SERVICE—REPEAT ORDERS

Biscuit Co.

September 22, 1931.

Lewellen Manufacturing Company,
Columbus, Indiana

Gentlemen:

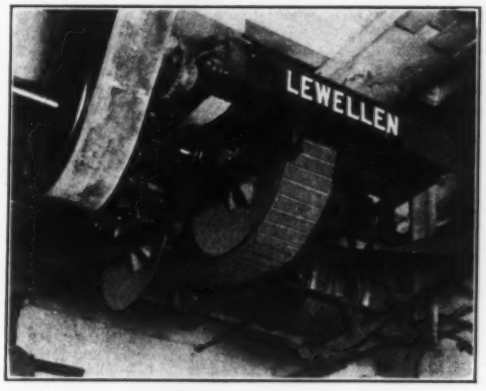
Eight years ago today we installed a size thirteen Lewellen Transmission and have used it continuously, running it eight hours or more per day, and we are so well pleased with same that it is a pleasure for us to write you this letter.

In the entire eight years we have not had one minute's trouble and have not spent one cent for parts. We are still operating it with the same belt that came with the machine. All we have done is used it and gave it a little oil every few months.

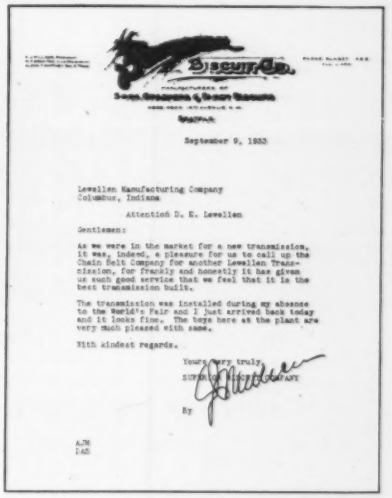
It is sure a wonderful machine.

Very truly yours,
Superior Biscuit Co.
By

A.M.L.



This Lewellen Variable Speed Transmission was installed at Superior Biscuit Co., Seattle, Wash. in 1923. Eight years later they express entire satisfaction with its service.



Biscuit Co.

September 9, 1933

Lewellen Manufacturing Company
Columbus, Indiana

Attention D. K. Lewellen

Gentlemen:

As we were in the market for a new transmission, it was, indeed, a pleasure for us to call up the Chain Belt Company for another Lewellen Transmission, for frankly and honestly it has given us such good service that we feel that it is the best transmission built.

The transmission was installed during my absence to the World's Fair and I just arrived back today and it looks fine. The boys here at the plant are very much pleased with same.

With kindest regards.

Yours very truly,
Superior Biscuit Company
By

A.M.
I.M.D.

Not a cent for repairs in eight years! The sincerity of this letter above is proven by their letter on the right, when they ordered their second unit.

Ten years of trouble-free service brings their verdict—a repeat order. Can we add anything to this proof of Lewellen efficiency? Send for catalog.

THE *Lewellen* MANUFACTURING CO.
COLUMBUS, INDIANA
"It costs no more to have the best"

NO ELBOWS

— straight vertical discharge pipe clears the motor on the No. 210

BROWN & SHARPE CENTRIFUGAL MOTORPUMP

. . . other features for long life and dependability

— drip-proof ball-bearing enclosed motor

— sealed bearing below motor

— ball-bearing support for driving shaft

Ask for circular giving complete information.

Brown & Sharpe Mfg. Co.
Providence, R. I.

1933 INDEX

The index for 1933 issues is ready for distribution. In addition to the usual contents index, a combined itemized index is included.

There is no charge for the index. However, it will be sent only to those readers who previously have requested a copy of each index as published, and to those writing in for this particular copy. MACHINE DESIGN, Penton Building, Cleveland.

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MACHINE DESIGN is a monthly technical publication conceived, edited and directed expressly for those executives and engineers responsible for the creation and improvement of machines built for sale, and for the selection of the materials and parts to be used.

Business Announcements and Sales Briefs

BANTAM BALL BEARING CO., South Bend, Ind., is now represented in the Chicago territory by R. B. Nichols, 1835 East Seventy-eighth street, Chicago. Until recently, Mr. Gardner has been handling the Southern Indiana and Southern Ohio territory. E. T. Cobb has been appointed by the company as representative on industrial ball and roller bearings in the state of Tennessee with headquarters at present at Pine Valley, Miss.

* * *

S. K. F. Industries Inc. has moved its general and executive offices from 40 East Thirty-fourth street, New York, to Front street and Erie avenue, Philadelphia.

* * *

W. E. McIlroy is now sales manager for Aluminum Industries Inc., Cincinnati.

* * *

Rodney Davis, 624 Race street, Philadelphia has been appointed distributor in the Philadelphia district for roller chains, sprockets, couplings and special chains manufactured by Diamond Chain & Mfg. Co., Indianapolis.

* * *

Youngstown Sheet & Tube Co., Youngstown, O., has moved its New York sales offices from 30 Church street to the forty-seventh floor, 500 Fifth avenue. L. E. Wallace is district manager.

* * *

G. G. McDonald, who during the past 15 years has been sales representative in the southern states for Lake Erie Bolt & Nut Co., Bourne Fuller Co., and Republic Steel Corp. has been made general manager of sales of Texas Nail & Wire Co., Galveston, Tex.

* * *

Frank B. MacMillin has been elected as president and general manager and Howard F. MacMillin as vice president and assistant general manager of Hydraulic Press Mfg. Co., Mount Gilead, O. Walter G. Tucker, son of the founder of the company, was advanced from the presidency to chairman of the board.

* * *

In the annual report of the president of Black & Decker Mfg. Co., Towson, Md., it is stated that the company passed from operating loss to operating profit in May, 1933, and since that time has shown a consistent increase in earnings. The volume during the past October, November and December was approximately 50 per cent greater than one year ago.

* * *

John S. Davey has been made special representative in the sales department of Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y. handling engineering problems. Charles E. S. Place has been named special representative in the sales department, developing and merchandising the recently acquired American Marsden locknuts. Dave Prosser, formerly with Lamson & Sessions Co., Cleveland, now represents the Russell, Burdsall & Ward company in the southwest Texas district, with headquarters at the Southland hotel, Dallas, Tex.

* * *

Charles H. Bauer is now merchandising manager of the V-belt department of Manhattan Rubber Mfg. Div., Passaic, N. J.

* * *

Stockholders of Connersville Blower Co. Inc., Connersville, Ind., have approved the change of the company's name to Roots-Connersville Blower Corp. This change was made to indicate the units making up the company.

* * *

Forrest U. Webster, for seven years advertising manager of Cutler-Hammer Inc., Milwaukee manufacturer of electric controls, has been appointed manager of merchandising sales and will continue to exercise supervision over advertising.

* * *

Charles H. Rhodes has been appointed assistant general manager of sales, in charge of bars and alloy steel, of Illinois Steel Co., Chicago, succeeding William I. Howland Jr., recently appointed vice president and general manager of sales.

* * *

Battelle Memorial Institute, Columbus, O., has commenced a new research project for S. S. White Dental Mfg. Co., Philadelphia. The investigation is in charge of Dr. O. E. Harder, assistant director of the Institute, and William A. Welcker, research engineer.

* * *

A. S. Hellstrom is now representing Bantam Ball Bearing Co., South Bend, Ind., in the Youngstown, Cleveland and Wheeling districts. Mr. Hellstrom, located at the Ohio Apts., 1625 Ohio avenue, Youngstown, is to cover accounts in the industrial line using ball and roller bearings with particular reference to bearings for steel mills and steel mill equipment.

* * *

F. Stanley Jones, who became identified with Colorado Fuel & Iron Co. as an errand boy in 1908 and who has been in the sales field nearly all the time since, has been appointed sales manager of wire products. W. H. Messner has been made sales manager of rolled products and George Tritch assistant manager of sales for the steel division.